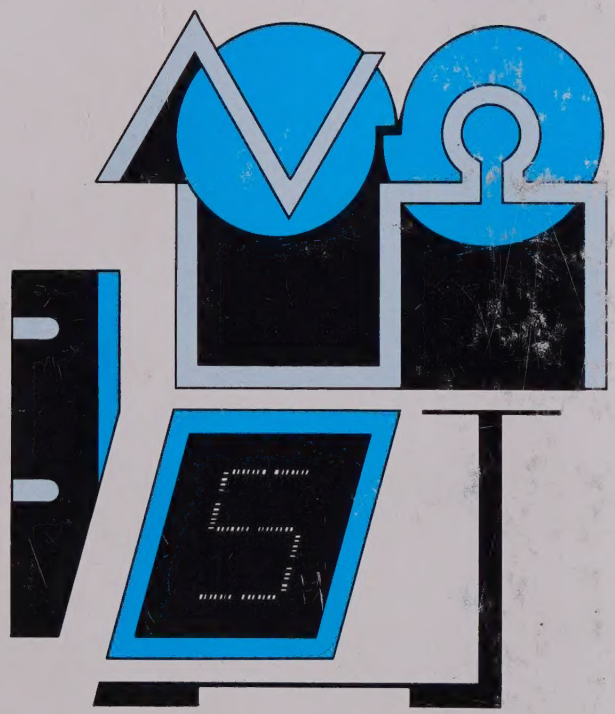
c.1

TM 500 stds.

INSTRUCTION MANUAL

5900

DIGITAL MULTIMETER



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INSTRUCTION MANUAL

MODEL 5900

DIGITAL MULTIMETER

DANA LABORATORIES, INC.
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ERRATA SHEET

1. Page 2-18, Table 2.8, GUARD

   Is: . . .must not exceed 500 volts. . .

   Should be: . . .must not exceed 250 volts. . .

2. Page 5-5

   a. Paragraph 5.16c

      Is: . . .reading of +20 ± 10 μV.

      Should be: . . .reading of +20 μV ± 10 μV.

   b. Paragraph 5.16h

      Is: . . .display as obtained in step i. Repeat steps i and j. . .

      Should be: . . .display as obtained in step g. Repeat steps g and h. . .

3. Page 5-6, paragraph 5.16j

   Is: . . .obtained in step g.

   Should be: . . .obtained in step i.

4. Page 6-7, Figure 6.4

   a. C36 is 10, 25V; should be jumper wire

   b. C35 is 10, 25V; should be 10, 50V

   c. Change assembly revision letter from K to L

5. Page 6-14, Figure 6.12

   a. Add C44 next to CR2.

   b. Add C45 next to CR12.

   c. Change assembly revision letter from H to J

6. Page 6-15, Figure 6.13

   a. Add C44, 10 μF, 50V between cathode and the anode of CR2. Positive to anode.

   b. R40 is 20K; should be 50K.

   c. R37 is FSV resistor; should be jumper.

   d. R7 and R8 on Ref. Amp Assy. 403658 are .01%; should be .1%.

   e. Delete C42.

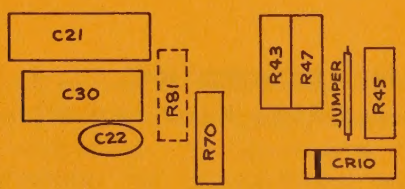
   f. Add C45, 150 pF between the cathode of CR12 and ground 4.

   g. Change Digitizer Assembly revision letter from H to J

ERRATA SHEET (continued)

7. Page 6-16, Figure 6.14
   a. The flat side of Q6 faces R29.
   b. Change assembly revision letter from H to J

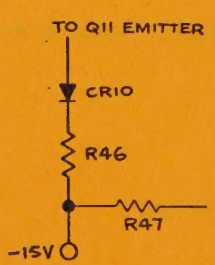
8. Page 6-22, Figure 6.20
   a. Add C31 to bottom side of board under K3.
   b. Move CR10, add jumper wire, and add R81 to bottom side of board as shown below.



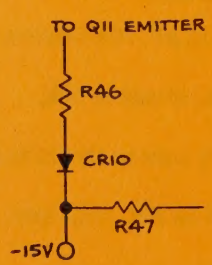
   c. Change assembly revision letter to C.

9. Page 6-23, Figure 6.21
   a. Add C31, .01 μF across the coil of K3.
   b. C8 is 2.2 NPO; should be 2.7 NPO
   c. R53 is 3.3; should be FSV 3.3 NOM.
   d. Add R81, 6.8K between C22 and the junction of C21, collector of Q19.
   e. R46 is 27.4K; should be 28.7K, 1%.
   f. Move CR10 as shown below.

Is:



Should be:

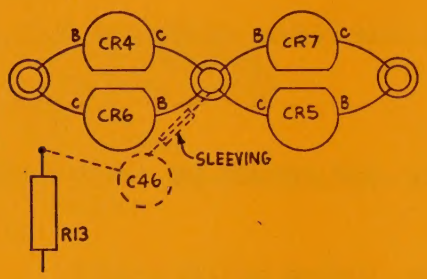


   g. Change assembly revision letter to C.

ERRATA SHEET (continued)

10. Page 6-24, Figure 6.22

    a. CR4 through CR7 are diodes; should be transistors mounted as shown below.



    b. Add C46 between teflon terminal common to CR4 through CR7 and top of R13 on the back side of PC Board as shown above.

    c. Change assembly revision letter from H to J.

11. Page 6-25, Figure 6.23

    a. C33 is 3.9 pF; should be 4.7 μF.

    b. CR4 through CR7 are HCD; should be MPS-H10 transistors. Emitter lead (middle) is clipped. Base = Anode, Collector = Cathode.

    c. Add C46, 10 pF between Anode (Base) of CR6 and emitter of Q1.

    d. Change assembly revision letter from H to J.

12. Page 7-3

    a. C36 is Dana P/N 110151;

    Should be: Dana P/N 600245 – JUMPER, GETTIG, L-2007-1

    b. C35 is Dana P/N 110151;

    Should be: Dana P/N 110158 – CAP, TANTA, 10 MFD, 50V, 10%, 05397, K10E50

13. Page 7-19

    R7 and R8 are .01%; should be .1%.

ERRATA SHEET (continued)

14. Page 7-20
    a. Add C44, Dana P/N 110158 – CAP, TANTA, 10 MFD, 50V, 10%, 05397, K10E50
    b. Delete C42
    c. Add C45, Dana P/N 101642 – CAP, CERAM, 150 PFD, 10%, 71471, SCD1X5F

15. Page 7-23
    a. R40 is Dana P/N 040233;
    Should be: Dana P/N 040234 – POT, CERMET, 50K, 10%, 73138, 89PR50K
    b. R37 is Dana P/N 001737;
    Should be: Dana P/N 600245 – JUMPER, GETTIG, L-2007-1

16. Page 7-33
    C8 is Dana P/N 100050;
    Should be: Dana P/N 100095 – CAP, CERAM, 2.7 ± .5 PFD, 500V, 56289, C030B102S2R7D

17. Page 7-35
    R46 is Dana P/N 010070;
    Should be: Dana P/N 010533 – RES, METAL, 28.7K, 1%, 81349, RN55D

18. Page 7-36
    Add R81, Dana P/N 000682 – RES, CARBON, 6.8K, 5%, 1/4W, 81349, RC07GF682J

19. Page 7-37
    C33 is Dana P/N 100079;
    Should be: Dana P/N 100081 – CAP, CERAM, 4.7 PFD, 1000V, 56289, C030B102E4R7D

20. Page 7-38
    a. Add CR46, Dana P/N 100075 – CAP, CERAM, 10 PFD, 1000V, 5%, 56289, 10TCCQ10
    b. CR4 through CR7 are Dana P/N 210035;
    Should be: Dana P/N 200197 – TRANS, SILICO, NPN, 04713, MPS-H10

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SECTION 1 GENERAL DESCRIPTION

1.1 INTRODUCTION.

1.2 The Model 5900 Digital Multimeter is a five-decade instrument with a sixth digit providing 60% overrange. The basic instrument is equipped for dc and dc/dc ratio measurements on five ranges. With the addition of the optional AC Converter, a-c and ac/dc ratio measurements on four ranges are available. The Ohms Converter, also optional, adds ohms measurements on eight ranges. Complete measurement capability of a fully equipped instrument is tabulated in table 1.1.

Table 1.1 - Measurement Capability

Range	FUNCTION		
	DC & DC/DC RATIO (Basic 5900)	Ohms (Model 52 Ohms Converter)	AC & AC/DC RATIO (Model 32 or 33 AC Converter)
.1V	X		
1V	X		X
10V	X		X
100V	X		X
1000V	X		X
10Ω		X	
.1 KΩ		X	
1 KΩ		X	
10 KΩ		X	
100 KΩ		X	
1000 KΩ		X	
10 MΩ		X	
100 MΩ		X	

1.3 Range can be selected manually or automatically (autorange). In AUTO range, the proper range for a particular measurement is selected automatically (full scale is defined as "100000" on any range). The instrument "upranges" at 160% of full scale and "downranges" at 15% of full scale. Polarity selection is also automatic and is displayed on the readout.

1.4 Two operating modes are provided. In Hold mode (RATE control on EXT), a measurement is held (displayed) until a single reading is commanded by an external command. The new measurement is then held until the next external command. In Periodic mode (RATE control CW), measurements are made automatically at the rate of approximately four per second.

1.5 The basic Model 5900 includes an analog output voltage that is proportional to the parameter being measured. The voltage, at 20 volts maximum, is available at a rear panel connector.

1.6 Also included as standard equipment is a solid-state isolated BCD output. TTL-compatible output levels of the reading, function, range, etc., plus a print command are provided. An additional line enables a new reading to be commanded externally. An optional isolated remote programming unit (Model 42) allows all operating commands to be made externally.

1.7 OPTIONS.

1.8 All optional accessories having model numbers are plug-in circuit boards that may be added at any time. A calibrated accessory board can be installed without affecting the d-c calibration of the basic instrument. An instrument shipped without PCB accessories will not be equipped with a Function Switching PCB assembly. This board must be added when accessory boards are installed. Analog accessories are identified in table 1.1.

1.9 Model 42 Remote Programming.

1.10 The Model 42 Remote Programming accessory allows the selection of function, range, filter, read command, etc., to be made externally. Auto range selection is also provided and appropriate timeouts are generated internally when ranging takes place. Remote Programming "overrides" all manual control settings to prevent erratic selections. Complete isolation of the programming unit is achieved by the use of photo-couplers and pulse transformers.

1.11 Rack-Mounting Flanges (403402).

1.12 Rack-Mounting Flanges are used where the instrument is to be installed in a relay-rack or cabinet.

1.13 High-Voltage Probe (641).

1.14 The High-Voltage Probe extends the voltage range of the instrument up to 10,000 volts (or 7500V rms). It is an insulated probe containing a 1000:1 voltage divider.

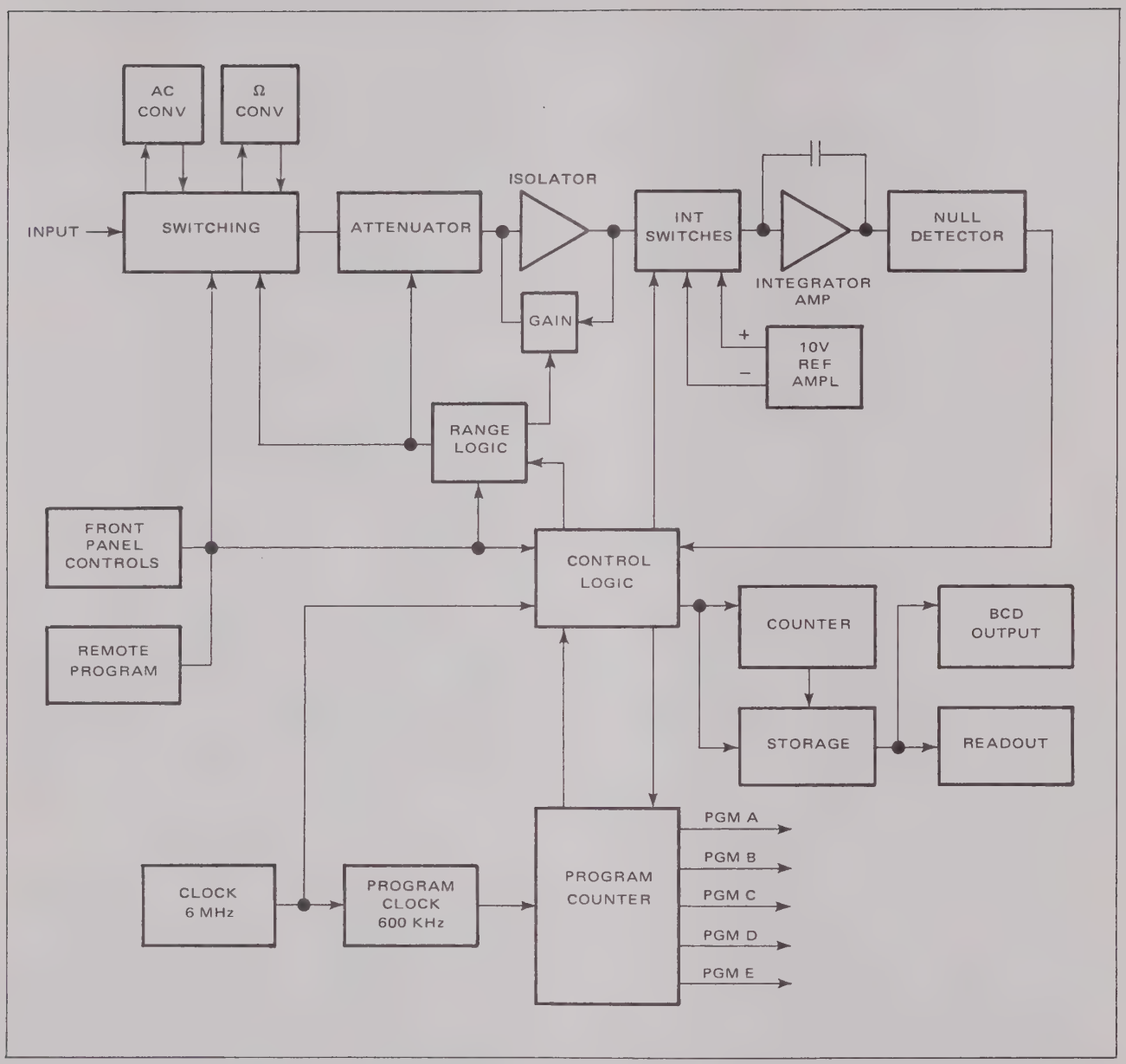


Figure 1.1 - Block Diagram - Model 5900

1.15 Current Shunt Set (651).

1.16 The Current Shunt Set consists of six precision shunt assemblies with values selected to produce a voltage drop that, measured in millivolts, has a numerical value equal to the current flow in milliamps or microamps.

1.17 ELECTRICAL DESCRIPTION.

1.18 The Model 5900 DMM is a dual slope integration instrument consisting of three main functional areas: signal conditioning, integrating, and control/display. A block diagram of the instrument is shown in figure 1.1.

1.19 The signal conditioning section includes the Switching p-c board, AC Converter, Ohms Converter, Attenuator, and Isolator. The function of these circuits is to convert the incoming signal to 10 VDC, full scale into the integrator.

1.20 The Integrating section consists of the Integrator amplifier, Null Detector and ± reference voltages. The

function of these circuits is to convert the conditioned input signal to an equivalent time period and to transmit this time period to the display portion of the DMM.

1.21 Dual slope integration operates as follows in a sequence of program (PGM) states:

a. Signal Integration (PGM-A). The integrator capacitor charges to a voltage proportional to the input voltage during a 20 msec sampling period.

b. Reference Integrate (PGM-C). During this period, the integrator capacitor discharges at a constant current. The time that the integrator requires to discharge (full discharge detected by the Null Detector) is measured by the counter. The data in the counter at the end of PGM-C is proportional to the input voltage.

c. Strobe (PGM-D). At this time, data in the counter is strobed into the storage latches and displayed – the print pulse is inhibited, however if an uprange or downrange command is generated by the Autorange logic. If a range change is required, the counter is reset and the program returns to PGM-A.

d. Reset (PGM-E). At PGM-E, all internal logic is reset in preparation for the next reading.

1.22 An additional control state, PGM-B, occurs after PGM-A and is a delay to allow for propagation time of the counter.

1.23 The Control/Display section generates the control signals necessary to operate the signal conditioning and integrating circuits.

1.24 MECHANICAL DESCRIPTION.

1.25 The ohms measurement option consists of a single printed-circuit board. The AC options both consist of two boards. The accessory boards plus the Digitizer, Isolator, and Function Switching board all plug into the Main Logic board called the Logic and Interconnection assembly. This board also carries much of the instrument logic.

1.26 The Function Switching board is used only when either or both of the options (AC and Ohms) are installed. With no options installed, the Function Switching board is replaced with the Switching Bypass board. The Switching Bypass merely connects the + Input (from input connector) directly to the Isolator input and the – Input to ground.

1.27 At the rear edge of the Logic and Interconnection assembly is a PCB connector that extends to the rear panel and serves as the BCD output connector J201. If the optional Remote Program board is installed, it is mounted on stand-offs above the Logic and Interconnection board with the PROGRAM INPUT connector (J202) available at the rear panel above the BCD OUTPUT connector.

1.28 The POWER input connector J203, the power transformer, and power transistors for the power supply are mounted on the rear panel of the instrument. Other power supply components are mounted on the Logic and Interconnection assembly. Also mounted on the rear panel, in addition to J201 and J202, is the rear INPUT connector J204, the ANALOG OUTPUT connector and common, the EXTernal REFerence connector and common, and the line fuse F201.

1.29 A dimensional outline of the Model 5900 is shown in figure 1.2.

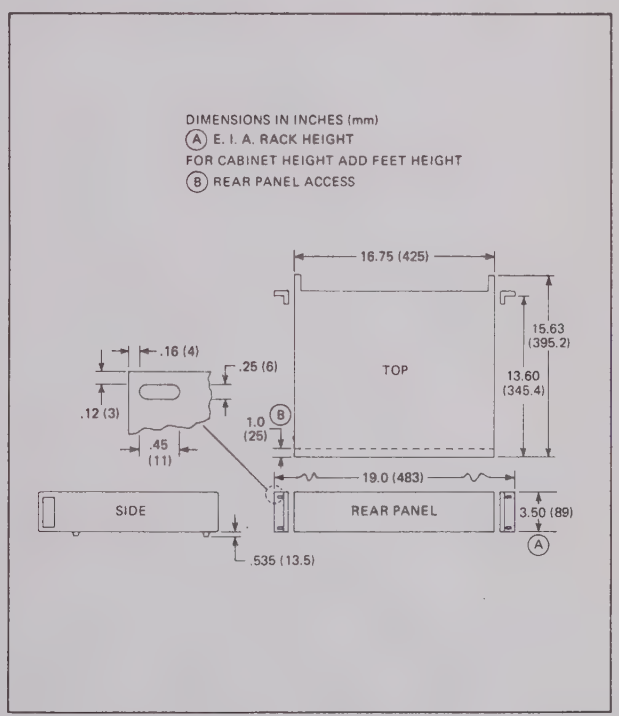


Figure 1.2 - Dimensions

1.30 SPECIFICATIONS.

1.31 Specifications are listed in table 1.2.

Table 1.2 - Specifications

GENERAL	
Conversion Technique:	Delayed Dual Slope
Signal Integration Time:	(60 Hz Standard) 16-2/3 msec 1-2/3 msec in Superfast
Reference Integration Time:	0 – 26-2/3 msec
Polarity Selection:	Automatic
Ranging:	Autoranging is standard, up-ranges at 160% F.S. and downranges at 15% F.S.
Read Rate:	3-1/3 rdg per sec minimum to hold
Maximum Common Mode Voltage:	1000V peak or DC Guard to case with logic common tied to case. 250V analog common to guard
Display:	5 full decades plus overrange digit (LED .4 inches high) plus decimal point and function annunciator
Overrange Indication:	Maximum reading is 160000 and "NO" annunciator is illuminated
Filter:	4-pole active
Analog Signal Output:	Input scaled and buffered 0 to ±16V. DC voltage equal to the readout is available for driving a recorder or as an accurate voltage source (Internal reference only)
Power Requirement:	100 - 240V 50 - 60 Hz Standard 400 Hz Optional 40 watts maximum
Weight:	16 lbs.
Dimensions:	3.5" x 14" x 16.75" (89 mm x 356 mm x 425 mm)
Temperature Range:	Operating 0°C - 50°C Storage –40°C - 70°C
Humidity Operating:	<75%; 25°C - 40°C <50%; 40°C - 50°C
Fan:	None required
Vibration, Operating:	0.025 double amplitude to 50 Hz for 15 minutes

DC VOLTS (Included in Basic Instrument)	
Ranges:	±.100000V, ±1.00000V, ±10.0000V, ±100.000V, ±1000.00V
Resolution:	0.001% of range 1 μV on 0.1V range
Overrange:	60% except 1000V range (1100 maximum input)
Maximum Input Voltage:	1100 VDC or 1500V peak AC on all ranges
Accuracy:	24 hours, 23°C ± 1°C (no adjustments) 10 Volt Range ±0.001% of full scale 1 - 1000 Volt Ranges ±(0.001% of reading +0.001% of full scale) .1 Volt Range ±(0.002% of reading +0.005% of full scale) 90 days, 23°C ± 5°C 10 Volt Range ±(0.001% of reading +0.001% of full scale) 1 - 1000 Volt Range ±(0.002% of reading +0.001% of full scale) .1 Volt Range ±(0.003% of reading +0.005% of full scale) 1 year, 23°C ± 5°C 10 Volt Range ±(0.003% of reading +0.001% of full scale) 1 - 1000 Volt Range ±(0.004% of reading +0.001% of full scale) 0.1 Volt Range ±(0.005% of reading +0.005% of full scale)
Temperature Coefficient:	0°C to 50°C 10 Volt Range ±(1.5 ppm of reading +.5 ppm of full scale)/°C 1 - 1000 Volt Range ±(3 ppm of reading +1 ppm of full scale)/°C 0.1 Volt Range ±(4 ppm of reading +5 ppm of full scale)/°C

Table 1.2 - Specifications (continued)

DC VOLTS (continued)	
Non-Linearity:	23°C ± 5°C All ranges: less than or equal to .5 digit non-linearity to 160% of full scale
Input Impedances:	0.1V-10V > 10,000 MΩ 100V-1000V > 10 MΩ
Input Bias Current:	10 pA at time of calibration (±100 pA for 30 days at 25°C)
Input Bias Current Temperature Coefficient:	±5 pA/°C
Normal Mode Rejection:	
Unfiltered	48 dB at every multiple of 60 Hz
Filtered	100 dB at 60 Hz
Common Mode Rejection:	(with 100Ω unbalance in either lead)
Unfiltered	140 dB at DC, 120 dB at 61 Hz and below plus an additional 48 dB at harmonics of 60 Hz
Filtered	140 dB DC to 61 Hz 126 dB 61 Hz to 100 kHz
Settling Time:	
Unfiltered	Settles to within 0.01% in 5 msec with 10 KΩ source, 10 msec on 100V range
Filtered	Settles to within 0.01% in 450 msec with 10 KΩ source

DATA OUTPUT (Included in the Basic Instrument)	
Information:	All BCD outputs of display, 4-bit Range code, function flags, polarity flags, special flags, and logic supplies
Logic Type:	Standard TTL levels, 8-4-2-1 BCD
Input Commands:	Superfast Data Disable System Direct Command
Maximum Read Rate:	26 per sec to full scale, 120 per sec to full scale in Superfast
Isolation:	Data output common may be floated up to 200V peak from power line common

AC VOLTS (Option 33 AC Converter, Averaging)	
Ranges:	1.00000V, 10.0000V, 100.000V, 1000.00V RMS
Resolution:	0.001% of range 10 μV on 1V range
Overrange:	60% except 1000V range (1000V RMS maximum input)
Maximum Input Voltage:	1000V RMS or 1500V peak, decreasing to 20V RMS at 1 MHz. $2x10^7$V Hz maximum on any range
Accuracy:	24 hours, 23°C ± 1°C 20 Hz to 30 Hz (filtered) ±(0.2% of reading +0.002% of full scale) 30 Hz to 60 Hz (filtered) ±(0.1% of reading +0.002% of full scale) 60 Hz to 100 Hz (filtered) ±(0.05% of reading +0.002% of full scale) 100 Hz to 20 kHz (filtered) ±(0.02% of reading +0.002% of full scale) 100 Hz to 300 Hz (no filter) ±(0.1% of reading +0.002% of full scale) 300 Hz to 20 kHz (no filter) ±(0.02% of reading +0.002% of full scale) 20 kHz to 100 kHz (both) ±(.02% of reading +0.005% of full scale) 100 kHz to 300 kHz (both) ±(0.1% of reading +0.01% of full scale) 300 kHz to 1 MHz (both) ±(0.5% of reading +0.05% of full scale) 90 days, 23°C ± 5°C add ±0.01% of reading to 24 hour specification 6 months, 23°C ± 5°C add ±0.02% of reading to 24 hour specification

AC VOLTS continued on page 1-6

Table 1.2 - Specifications (continued)

AC VOLTS (continued)	
Temperature Coefficient:	0°C to 50°C 50 Hz to 20 kHz (filtered) ±(0.003% of reading +0.0005% of full scale)/°C 20 kHz to 100 kHz (both) ±(0.005% of reading +0.001% of full scale)/°C 100 kHz to 1 MHz (both) ±(0.01% of reading +0.01% of full scale)/°C
Input Impedances:	1 MΩ ± 0.1% in series with 0.22 μF shunted by less than 100 pF to common
Common Mode Rejection:	(with 100Ω unbalance in either lead, DC to 60 Hz) 1 Volt Range 120 dB 10 Volt Range 100 dB 100 Volt Range 80 dB 1000 Volt Range 60 dB
Settling Time:	
Unfiltered	Settles to within rated accuracy in 200 msec
Filtered	Settles to within rated accuracy in 600 msec
(Zero to full scale or full scale to 10% of full scale)	

REMOTE PROGRAMMING (Option 42)	
Input Information:	Provides isolated programming of all DMM functions and ranges
Logic Type:	Standard TTL levels, 8-4-2-1 BCD
Functions:	Function lines are programmed by a closure to ground (low TTL level)
Ranges:	Range lines are 8-4-2-1 coded positive true logic
Command Modes:	Direct Command Timeout Command Superfast

OHMS (Option 52)	
Ranges:	10.0000Ω, .100000 KΩ, 1.00000 KΩ, 10.0000 KΩ, 100.000 KΩ, 1000.00 KΩ, 10.0000 MΩ, 100.000 MΩ
Resolution:	0.001% of range 100 μΩ on 10Ω range
Overrange:	60% on all ranges
Maximum Input Voltage:	±500V peak on all ranges
Measurement Scheme:	True 4-wire
Accuracy:	24 hours, 23°C ± 1°C 10 ohm Range ±(0.005% of reading +0.005% of full scale) .1 - 1000 kilohm Range ±(0.002% of reading +0.001% of full scale) 10 megohm Range ±(0.01% of reading +0.001% of full scale) 100 megohm Range ±(0.03% of reading +0.001% of full scale) 90 days, 23°C ± 5°C 10 ohm Range ±(0.005% of reading +0.005% of full scale) .1 - 1000 kilohm Range ±(0.003% of reading +0.001% of full scale) 10 megohm Range ±(0.03% of reading +0.001% of full scale) 100 megohm Range ±(0.05% of reading +0.001% of full scale)
Temperature Coefficient:	0°C to 50°C 10 ohm Range ±(8 ppm of reading +5 ppm of full scale)/°C .1 - 1 kilohm Range ±(7 ppm of reading +1 ppm of full scale)/°C 10 - 1000 kilohm Range ±(6 ppm of reading +1 ppm of full scale)/°C 10 megohm Range ±(30 ppm of reading +1 ppm of full scale)/°C 100 megohm Range ±(50 ppm of reading +1 ppm of full scale)/°C

Table 1.2 - Specifications (continued)

OHMS (continued)	
Open Circuit Voltage:	10Ω-1 KΩ 10V maximum 10 KΩ-100 MΩ 22V maximum
Current Through Unknown:	10 ohm Range 10.101 mA 100 ohm Range 11.1111 mA 1 kilohm Range 1.11111 mA 10 kilohm Range 1 mA 100 kilohm Range 100 μA 1000 kilohm Range 10 μA 10 megohm Range 1 μA 100 megohm Range 100 nA
Normal Mode Rejection: **Unfiltered** **Filtered**	 48 dB at every multiple of 60 Hz 100 dB at 60 Hz
Common Mode Rejection: **Unfiltered** **Filtered**	(with 100Ω unbalance in either lead) 140 dB at DC, 120 dB at 61 Hz plus an additional 48 dB at harmonics of 60 Hz 140 dB DC to 61 Hz 126 dB 61 Hz to 100 kHz
Settling Time: **to rated accuracy**	 10Ω-10 MΩ 30 msec 100 MΩ 300 msec
Ohms Guard:	Use "Analog-Out" low on rear panel when in ohms

SUPERFAST	
Ranges & Functions:	All ranges and functions
Command:	Must be commanded through rear printer connector (J201), or through programmer option (J202).
Display:	Four digit display with 60% overrange
Maximum Read Rate:	(60 Hz standard) 98 readings/sec. minimum at full overrange. 120 readings/sec. at full scale
Accuracy:	Standard accuracy for range and function plus .03% of reading plus .03% of full scale

3-WIRE RATIO (Included in Basic Instrument)	
3-Wire (Standard)	ac/dc, dc/dc
Readout:	$\frac{(10V)}{(Ref\ V)} \times \frac{(Input)}{(F.S.\ of\ range)} \times 10$
Reference Voltage Range:	+1V to +10.5V
Maximum Input Voltage:	Same as function
Accuracy:	24 hours, 23°C ± 1°C DC, AC – same as respective 24 hour, 23°C ± 1°C spec. times $\frac{(10V)}{(Ref\ V)}$
Reference Input Impedance:	100 MΩ
Reference Settling Time:	One second to 0.01% accuracy

4-WIRE RATIO (Option 62)	
4-Wire (Option 62)	ac/dc, dc/dc
Readout:	$\frac{(10V)}{(Ref\ V)} \times \frac{(Input)}{(F.S.\ of\ range)} \times 10$
Reference Voltage Range:	+1V to +10.5V
Maximum Input Voltage:	Same as function
Accuracy:	24 hours, 23°C ± 1°C DC, AC – same as respective 24 hour, 23°C ±1°C spec. times $\frac{(10V)}{(Ref\ V)} \times 2$
Reference Input Impedance:	(Both leads with respect to –sig. input) 100 MΩ min. + lead 10 MΩ ± 10% – lead
Reference Input to Sig. Common Voltage:	±15V max. (either input)
Reference Settling Time:	50 msec to 0.01% of rated accuracy

Table 1.2 - Specifications (continued)

AC VOLTS TRUE RMS	
Ranges:	1.00000V, 10.0000V, 100.000V, 1000.00V RMS
Resolution:	0.001% of range 10 μV on 1V range
Overrange:	60%, (within maximum input voltage limit)
Maximum Input Voltage:	1000V DC/RMS or 1500V peak, decreasing to 20V RMS at 1 MHz. $2x10^7$ VHz maximum on any range
Maximum Crest Factor: **(Pulses at 1 kHz Repetition Rate)**	7:1 at full-scale 22:1 at 10% of full-scale
Accuracy: AC Mode	90 days, 23°C ± 5°C 20 Hz – 30 Hz (filtered) ±(.5% of reading +.03% of full scale) 30 Hz – 50 Hz (filtered) ±(.2% of reading +.03% of full scale) 50 Hz to 100 Hz (filtered) ±(.1% of reading +.03% of full scale) 100 Hz – 20 kHz (filtered) ±(.07% of reading +.03% of full scale) 200 Hz to 20 kHz (no filter) ±(.07% of reading +.03% of full scale) 20 kHz – 50 kHz (both) ±(.1% of reading +.1% of full scale) 50 kHz – 100 kHz (both) ±(.2% of reading +.2% of full scale) 10, 100, 1000V range 100 kHz – 300 kHz ±(3% of reading +.5% of full scale) 1V range 100 kHz – 300 kHz ±(5% of reading +1% of full scale)

Accuracy: *(con't)* AC Mode *(con't)*	300 kHz – 1 MHz Add [10 f (MHz) % of reading +.5% of full scale to 300 kHz specification]
AC & DC Mode	Add ±.02% of full scale to AC specification
For inputs greater than 500V multiply % of reading spec by $(1 + \frac{Vin}{2000})$ 1 Hz operation available on special request	
Temperature Coefficient:	0°C to 50°C AC Mode (to 20 kHz) ±(.004% of reading +.003% of full scale)/°C AC & DC Mode (to 20 kHz) ±(.004% of reading +.005% of full scale)/°C
Input Impedances: AC Mode	1 Megohm ±0.1% in series with 0.22 μF shunted by less than 100 pF to common
Common Mode Rejection:	With 100Ω unbalance in either lead DC to 60 Hz: 120 dB
Settling Time:	(to within .1% of range) 0 to Full Scale Step Filter Out 80 msec Filter In 350 msec Full Scale to 10% FS Step Filter Out 100 msec Filter In 400 msec

2.1 UNPACKING AND INSPECTION.

2.2 The Model 5900 DMM is packed in a molded plastic-foam form within a cardboard carton for shipment. The plastic form holds the DMM securely in the carton and absorbs any reasonable external shock normally encountered in transit. Prior to unpacking, examine the exterior of the shipping carton for any signs of damage. Carefully remove the DMM from the carton and inspect the exterior of the instrument for any signs of damage. If damage is found, notify the carrier immediately.

2.3 Included with the instrument in the packing container are the instruction manual, power cord, and rear input and BCD output mating connectors. With instruments equipped with remote programming, a mating connector for that accessory is included.

2.4 BENCH OPERATION.

2.5 Each Model 5900 is equipped with a tilt bail or "kickstand" to enable the front of the instrument to be elevated for convenient bench use. The tilt bail is attached to the two front supporting "feet" at the bottom of the instrument. For use, the bail is pulled down to its supporting position.

2.6 RACK MOUNTING.

2.7 The instrument can be mounted in a standard 19-inch rack with the optional rack-mounting flanges (403402, includes attaching hardware). To install the flanges, proceed as follows:

a. With instrument on its side, remove four Phillips-head screws holding bottom cover. Remove cover. Remove screws holding feet (and bail) in place. Replace bottom cover.

b. Place one of the supplied screws through each of the two holes in the mounting flange (figure 2.1). Thread a securing nut onto each screw just enough to attach it to the screw (approximately one turn).

c. Place the mounting flange onto the mounting slot in the instrument side panel so that the securing nuts fit entirely into the slot. Be sure the rack-mount slots on the flange are toward the front of the instrument.

d. Tighten screws. The securing nuts will rotate and hold the flange securely in place.

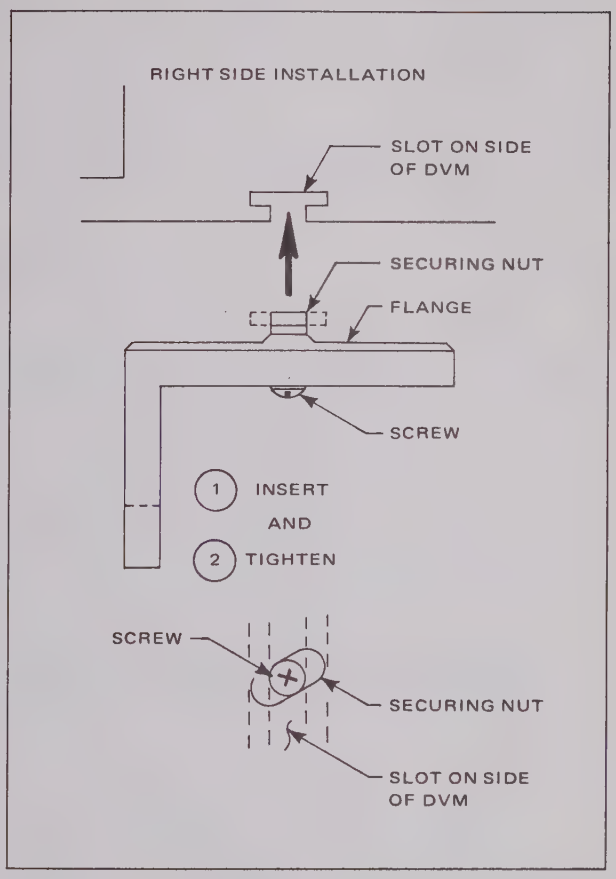


Figure 2.1 - Rack Mount Installation

2.8 POWER CONNECTIONS.

2.9 Standard units operate on either 115 volts or 230 volts, 50 to 60 Hz (400 Hz available). Power consumption is less than 40 watts. Operation on either of the two line voltages is selectable by a slide switch on the rear panel. Operation on 100/200 volts or 120/240 volts is possible by simple rewiring of the power transformer secondary wires:

a. For operation on 100/200 volts, cut the brown wire 1" from the transformer and splice it to the red wire on the transformer; cut the blue wire 1" from the transformer and splice it to the violet wire.

b. For operation on 120/240 volts, cut the brown wire 1" from the transformer and splice it to the black wire; cut the blue wire and splice it to the yellow wire on the transformer.

2.10 A standard power cable having a three-pin plug is supplied with the instrument. It connects to POWER connector J203. The ground pin (round) is attached to the instrument case. It is important that this pin be connected to a good quality earth ground.

2.11 Fuse receptacle F201 on the rear panel is equipped with a .5 amp fuse in domestic units.

2.12 INPUT/OUTPUT CABLING.

2.13 Binding Posts.

2.14 Several connectors on the Model 5900 consist of a pair of binding posts spaced so as to accept standard "banana" plugs. The connectors are:

Front Panel	Rear Panel
± INPUT	± ANALOG OUTPUT
± OHMS CURRENT	± REFerence INput

2.15 Input cables to fit this type of connector can be ordered from Dana (P/N 402190). Figure 2.2 is a wiring diagram of this cable included for assistance to users desiring to construct their own cables.

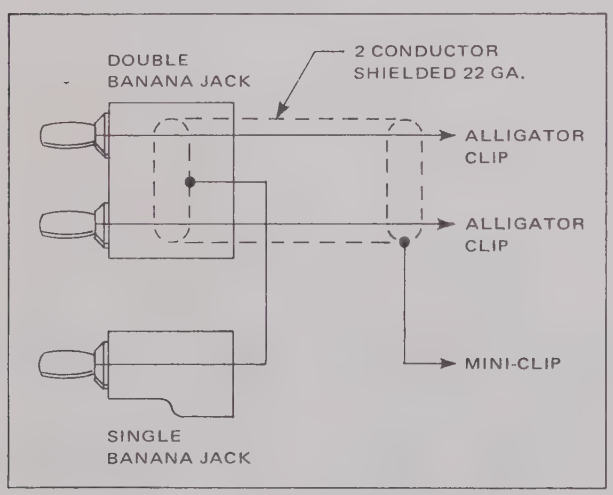


Figure 2.2 - Cabling Diagram, Binding Posts

2.16 Rear Input Connector.

2.17 The rear input connector J204 is a Viking TKR7-101 (Dana P/N 600673). The mating connector is TKP7-100 (Dana P/N 600616) and is supplied with the basic instrument. The instrument accepts inputs applied to this connector or inputs applied to the front-panel binding posts. The rear-panel input lines are wired in parallel with the front-panel input lines. It is recommended that the cable for the mating connector be constructed as shown in figure 2.3 using two two-conductor shielded cables. Other configurations may be desirable depending on the ohms measuring method to be used (see paragraph 2.28).

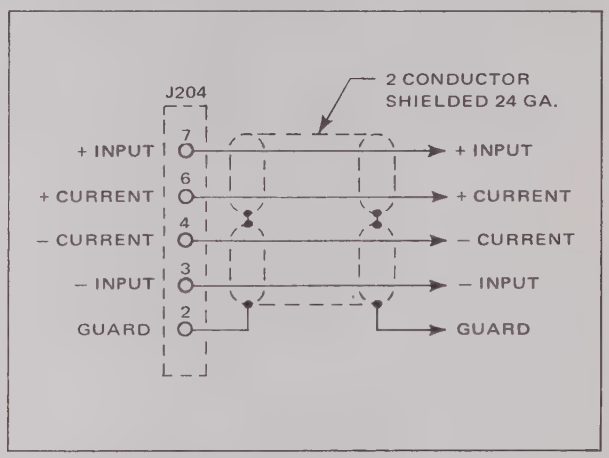


Figure 2.3 - Cabling Diagram, Rear Input

2.18 MANUAL OPERATION.

2.19 Controls.

2.20 All operating controls are located on the front panel of the instrument. They are shown in figure 2.5 and their operation described in table 2.1. Description of Systems operation begins in paragraph 2.44.

2.21 DISPLAY.

2.22 The display consists of 6 LED decimal readout devices with moving decimal point. The decimal point moves in conjunction with the range switch or automatically in auto range. Maximum usable readout with overrange is 159999. Overload is indicated by a NO and 160000 readout. A non-compatible range and function is indicated by a NO. However, mechanical interlocks are provided to prevent illegal combinations from the front panel. Figure 2.4 illustrates the readout, NO indicator, polarity sign and the annunciator.

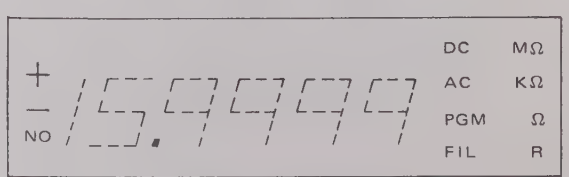


Figure 2.4 - Readout

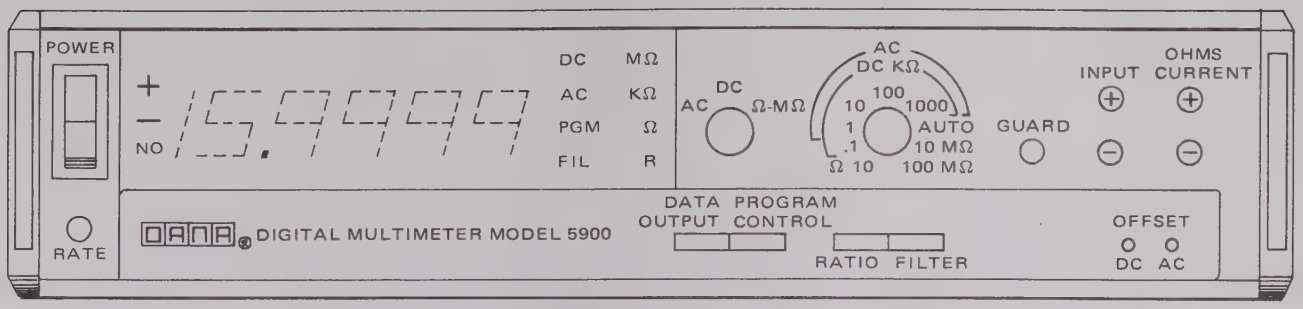


Figure 2.5 - Front Panel

Table 2.1 - Operating Controls

Control	Position	Function
Power (rocker switch)	ON (up)	Applies power to instrument
	OFF (down)	Removes power from instrument
Function Select (rotary switch)	AC	Selects the measurement of AC voltages on the 1, 10, 100, and 1000 volt ranges (max. input, 1000V RMS)
	DC	Selects the measurement of DC voltages on the .1, 1, 10, 100, and 1000 volt ranges (max. input, 1000V)
	Ω-MΩ*	Selects the measurement of resistance on the 10 ohm range; on the .1, 1, 10, 100, and 1000 kilohms ranges; or on the 10 or 100 Megohm ranges
Range Select (rotary switch)	AUTO	Selects Auto Range in which the optimum range is selected automatically by internal circuits. Uprange occurs at 160% of full scale; downrange occurs at 15% of full scale
	Other Positions	Enables manual selection of fixed ranges. Ranges permissible for each function are inscribed on the panel
DATA OUTPUT (pushbutton)	Depressed	Enables the print pulse causing BCD data at P201 to be recorded by printer, or other output device. (Output data is present at P201 regardless of the position of this switch.)
PROGRAM CONTROL (pushbutton)	Depressed	Enables the selection of range, function, and mode to be made externally through the remote programming connector and disables all front panel controls
RATIO (pushbutton)	Depressed	Selects a ratio measurement in which the readout represents the ratio of the input to an external d-c reference voltage (applied at terminals on the rear panel) multiplier by 10: $E_{in}/E_{Ref} \times 10$
FILTER (pushbutton)	Depressed	Adds an active four-pole filter across the input circuit
RATE (pot)	EXT (ccw)	Selects the Hold mode. A new reading is initiated through the remote program input
	CW	Increase periodic read rate to a maximum of four readings/second

*NOTE: Ohms input terminals are open in AC or DC function.

2.23 MEASUREMENT CONNECTIONS.

NOTE

Before taking any measurements, refer to the list of maximum input voltages, table 2.2.

Table 2.2 - Maximum Input Voltage

CAUTION

Do not exceed the following maximum inputs:

DC	1000 VDC or RMS AC
AC	1000V RMS decreasing to 20V RMS at 1 MHz (see figure 2.7)
Ω	±500V peak between +I and –I (1000V RMS if in DC or AC function.)
RATIO	Input: same as function selected Reference: +10.5V, –0.5V
GUARD	Voltage between GUARD and – INPUT must not exceed 250 volts or damage to the instrument may result

2.24 Basic Voltage Measurement.

2.25 An ac or dc voltage measurement connection recommended to minimize the effects of noise requires a two-conductor shielded cable connected as shown in figure 2.6.

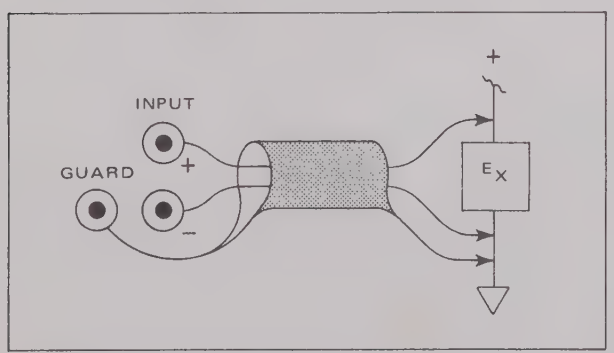


Figure 2.6 - Basic Voltage Measurement Connections

2.26 For all voltage measurements, the GUARD lead and the – INPUT lead are connected to the measurement point nearest ground potential. Somewhat less shielding is achieved by placing a shorting bar between – INPUT and GUARD and shorting the single banana plug (shield) to the – INPUT side of the double banana plug at the input connector. This arrangement is adequate for measuring all but low voltage (mV) levels and/or in high-noise environments.

2.27 When making "floating" voltage measurements (both measurement points above ground potential), do not connect GUARD to measurement ground without making sure that the voltage between GUARD and – INPUT does not exceed 250 volts.

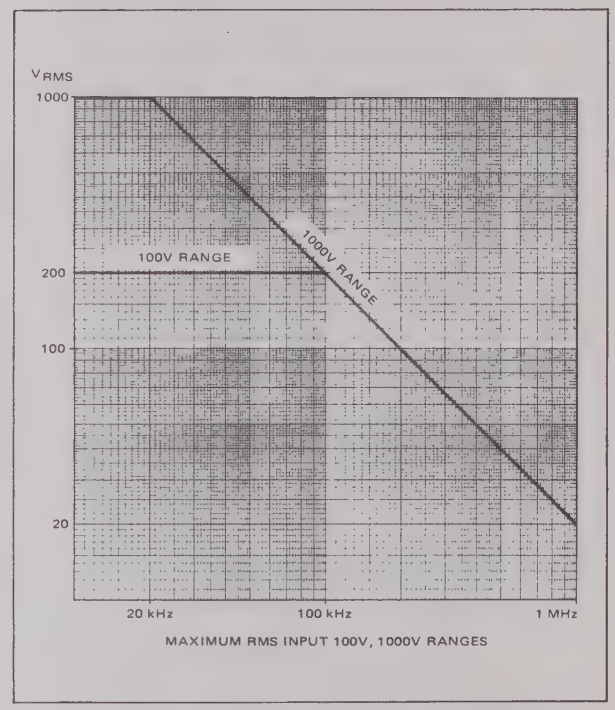


Figure 2.7 - Maximum RMS Input Voltage

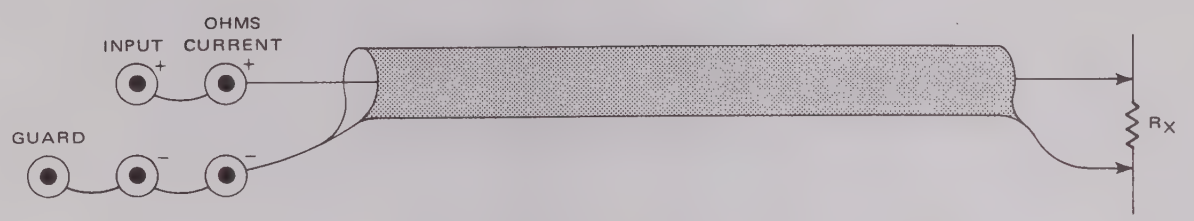
2.28 Ohms Measurement.

2.29 Ohms measurement in the Model 5900 consists of the application of a known current through the unknown resistance (R_X) and measuring the ratio of the voltage drop across R_X to the drop across an internal "full-scale" resistor (E_{RX}/E_{FS}). Current through R_X is applied through leads from the ± OHMS CURRENT terminals. The voltage drop is sensed by the ± INPUT terminals.

2.30 TWO-WIRE MEASUREMENTS.

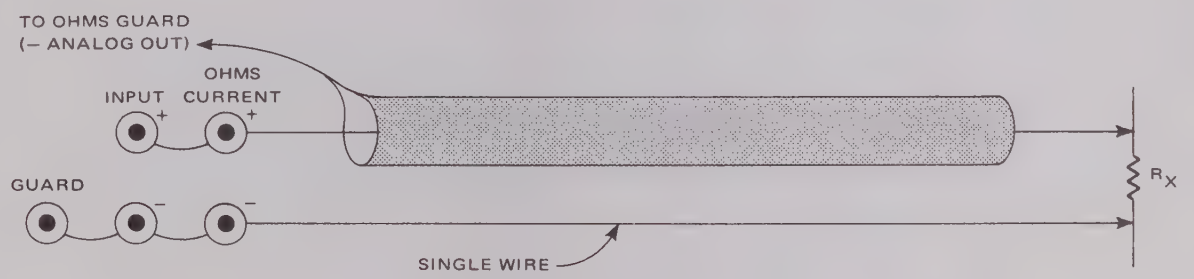
2.31 Connections for a simple two-wire shielded ohms measurement are shown in figure 2.8a. It consists simply of a single-conductor shielded cable with the conductor serving as both the + CURRENT and + INPUT leads and the shield

(a)



USED FOR NORMAL MEASUREMENTS ON ALL BUT THE 10 and 100Ω RANGES.

(b)



USED ON 100 MΩ RANGE WHERE CABLE LEAKAGE IS A PROBLEM.

(c)

USED ON 100 MΩ RANGE IN HIGH-NOISE ENVIRONMENT; MINIMIZES BOTH NOISE AND LEAKAGE PROBLEMS.

Figure 2.8 - Two Wire Ohms Measurements

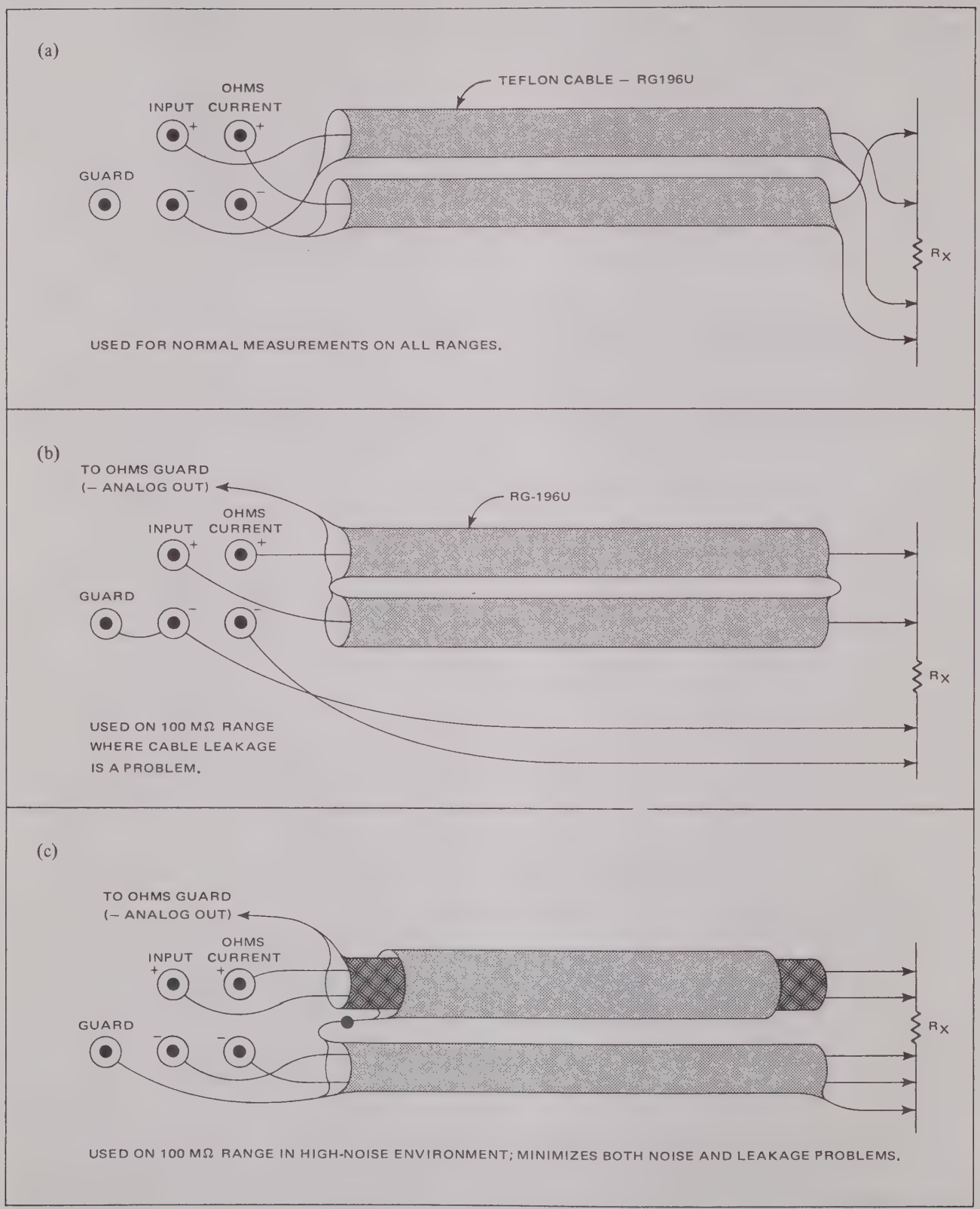


Figure 2.9 - Four Wire Ohms Measurement

carrying – CURRENT and – INPUT. While reasonably accurate measurements can be made with this method, shunt leakage problems result from the parallel combinations of R_X and the cable impedance. This causes loss of accuracy, especially at high resistance (100 MΩ range). Also, lead resistance becomes a factor in the 10 and 100 ohms ranges; the four wire measurement system is recommended for these ranges.

2.32 A more accurate two-wire measurement connection is shown in figure 2.8b. The + INPUT and + CURRENT, – INPUT and – CURRENT terminals are again tied together. But now, the positive side is a single-conductor, shielded cable with the shield tied to Ohms Guard. Ohms Guard is the low ANALOG OUTPUT terminal on the rear panel of the Model 5900 when ohms is selected. The negative side is a single wire connected as shown. Guard current is present in the low side, but the leakage problems of the first configuration are eliminated.

2.33 In high noise-level environments, the configuration shown in figure 2.8c is recommended. This method also eliminates error due to shunt leakage, but provides more complete shielding. The positive terminals are tied together and carried in a single-conductor, double-shielded cable with the inner shield tied to Ohms Guard (– ANALOG OUTPUT). The outer shield is tied to GUARD. The negative terminals are tied together and carried in a single-conductor shielded cable with the shield tied to GUARD. This configuration eliminates guard current sensitivity, thereby increasing guarding characteristics.

2.34 FOUR-WIRE MEASUREMENTS.

2.35 In most system applications, the device to be measured is located at a remote location requiring interconnection by cables of lengths from several to possibly hundreds of feet. When measuring low resistance values over long cables, most lead resistance problems can be solved by the use of a four-wire measurement system.

2.36 For high resistance measurements over long cables, other problems are encountered: noise pick-up, leakage resistance, and capacitive loading of the system. These problems can be minimized by proper shielding and the use of ohms guard.

2.37 Figure 2.9a shows a basic shielded four-wire ohms measurement configuration. This method uses two single-conductor shielded teflon cables. The conductors carry the positive sides of the INPUT and CURRENT lines while each shield carries the low side.

2.38 This configuration, although shielded, places the shield capacitance and cable leakage in parallel with R_X. This results in loss of accuracy and slow measurements. In addition, it is very responsive to the triboelectric effect at high resistance measurements.

2.39 Better guarding is achieved by the use of the configuration shown in figure 2.9b. Here again, RG196U teflon dielectric cable (either single-conductor shielded or two-conductor shielded) is used on the positive terminals. The shield(s) are connected to Ohms Guard (low ANALOG OUTPUT terminal). The negative leads are single wires with the – INPUT terminal tied to GUARD.

2.40 This eliminates much of the shunt leakage problem of the previous configuration since guard current now flows through the low side of the measurement circuit. Measurement is much faster since the shield capacity is driven by the guard current.

2.41 A high-noise environment calls for the "super" configuration shown in figure 2.9c. Here, a two-conductor, double-shielded cable is used as the positive leads. The inner shield is tied to Ohms Guard. A two-conductor shielded cable is used as the negative leads. Its shield is tied to GUARD and to the outer shield of the positive cable. The shield is also tied to – CURRENT at the measurement point. This configuration maintains high guarding characteristics while eliminating guard current sensitivity.

2.42 Ratio Measurements.

2.43 Ratio measurements are made by applying a positive d-c voltage to the reference input terminals on the rear panel and an input signal of any function at the front input terminals. For DC/DC, DC-MV/DC, or AC/DC ratios, the reference voltage must be within the range of +1V to +10.5V. Input signal limitations (numerator) are the same as those given for conventional measurement of the particular function (table 2.2). The readout is the ratio multiplied by ten: $E_{input}/E_{reference} \times 10$. In the standard instrument the – INPUT terminal is internally connected to the – REF input terminal; in instruments equipped with the option 62 4-wire ratio, both reference inputs are floating.

2.44 SYSTEM CAPABILITIES.

2.45 The 5900 has two system interface connectors designated as J201 (PRINTER OUTPUT) and J202 (PROGRAM INPUT) mounted on the rear panel of the instrument (figure 2.10). The following is a brief description of the capabilities of each connector.

2.46 Printer Output - J201.

2.47 Through this connector the 5900 supplies BCD representations of the decimal display; various flags or indicators of the mode of operation, function and range; and a print command. Provision has also been made for 60 Hz instruments to accept a fast (20 readings per second maximum) or a superfast (101 readings per second minimum) read command. In 50 Hz units, the fast command obtains 17 readings per second, minimum, and the superfast command 93 readings per second.

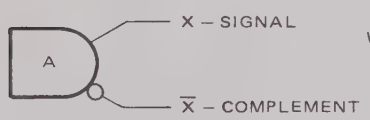
2.48 Program Input.

2.49 Through this connector the 5900 receives externally generated signals that select the function, range, mode of operation, and initiate the read commands.

2.50 LOGIC LEVELS AND ELECTRONIC INTERFACE.

2.51 TTL-compatible positive-true logic levels are used in the 5900. In some instances, however, complementary signals are used. These terms are more specifically defined below:

Signals and Their Complements –



WHERE:

X	$\overline{X}$
1	0
0	1

2.52 If the non-inverting output of gate A is defined as signal X, then it follows that the inverting output is $\overline{X}$; in other words, the complement of X is $\overline{X}$. The truth table shows that the two signals X and $\overline{X}$, are by definition, in opposite logic states (see table 2.3).

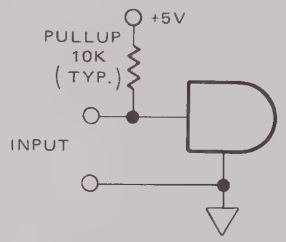
Table 2.3 - Positive True Logic Relationships

Signal	Logic State	Voltage Level of Output Line "X"	Voltage Level of Output Line "$\overline{X}$"
"X"	True or "1"	2.4 - 5.0 Volts	0.0 - 0.4
	False or "0"	0.0 - 0.4 Volts	2.4 - 5.0

2.53 As seen above, if gate A has a true or "1" level on output X, its voltage level is the most positive of the two ranges present, and output $\overline{X}$ must be in a false or "0" state with the lowest or most negative voltage range present. The reverse would be true for a false or "0" level on output X.

2.54 Driving the Inputs.

2.55 All inputs are TTL compatible and most are the equivalent of one 7400 series TTL input with a pull-up resistor for contact closure operation.



2.56 TTL Loading Conditions.

2.57 To input a "1" level the pull-up resistor will supply the necessary source current (40 μA) to maintain the minimum 2.4 volts. In fact, the pull-up resistor will maintain a

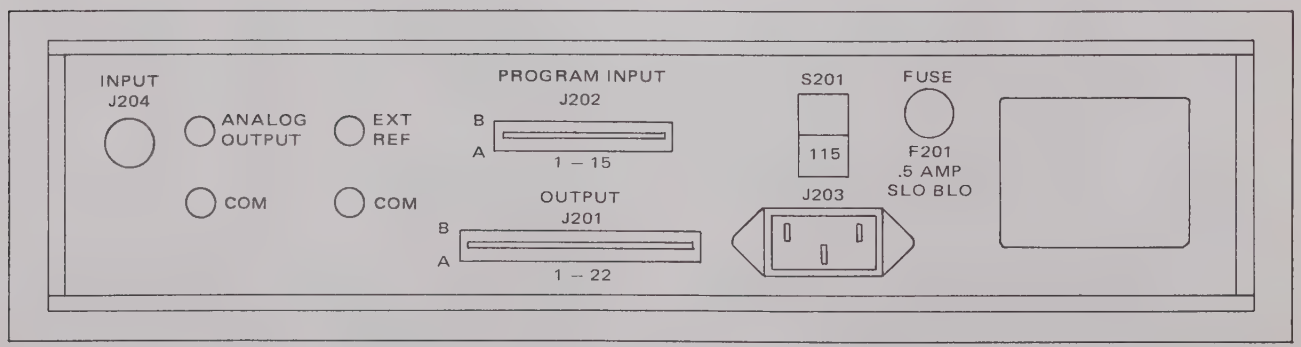
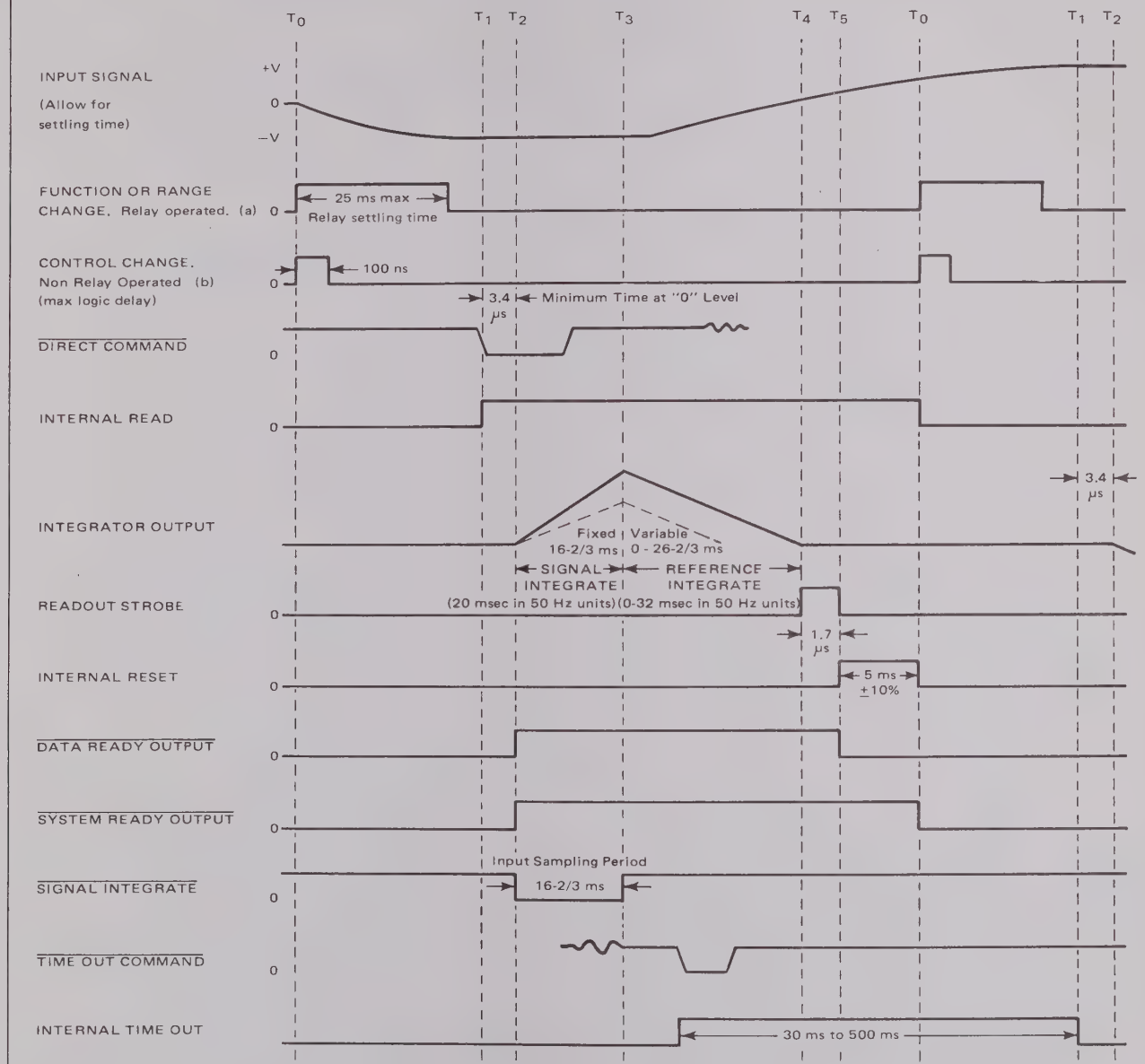


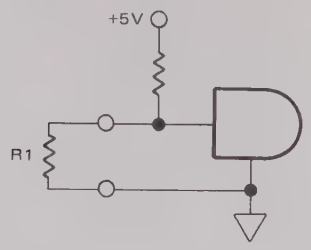
Figure 2.10 - Rear Panel



(a) Such as: Function, Range, Filter and Ratio.
(b) Such as: Super Fast, Data Disable, Program Storage System Control and Hold

Figure 2.11 - Measurement Sequence

one level as long as the input source resistance (R1) to ground is greater than 15K ohms.



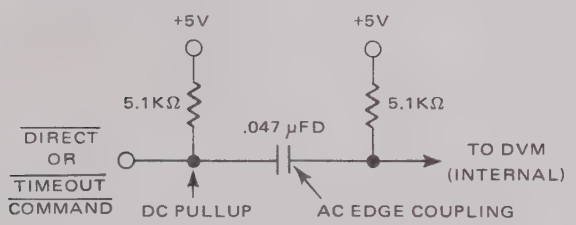
2.58 To input a "0" level, at least 2.0 ma of current must be sinked maintaining the input voltage below 0.4 volts. This requires a resistance to ground of 200 ohms or less.

2.59 Exceptions to Input Loading Conditions.

a. $\overline{\text{Program Storage}}$ Input (J202, pin B-15) is the equivalent of 3 TTL inputs and requires a minimum 5.8 ma sinking current, or 68 ohms or less to common.

b. Maximum input voltage level, referenced to common, must not exceed 5.5 volts peak. Otherwise, gate destruction will occur.

c. The $\overline{\text{Direct}}$ and $\overline{\text{Time Out Commands}}$ are AC coupled with pull-up resistors to +5 volts. These inputs are compatible with TTL outputs or contact closures to ground. The AC coupling does require that rise and fall times be less than 100 μseconds. This input circuit is illustrated below:



d. Digital output common can be floated as high as 200 VDC above power line ground.

2.60 TTL Output Capabilities.

2.61 The 5900 electrical outputs are specified to drive two TTL inputs such as described in the TTL loading section. Summary:

False: 0 to +0.4V
True: +2.4 to +5.0V
Fan out: 2 minimum
Maximum Capacitance Load: 500 pF

2.62 Timing Sequence.

2.63 The standard remote mode of operation of the 5900 is to initiate a reading sequence with each $\overline{\text{Direct Command}}$ received through the programmer, providing that sufficient time has been allowed between commands for the reading to be completed. This reading sequence is illustrated in figure 2.11.

$T_1 - T_0$ During this period the input signal must finish settling to within the desired accuracy. Any control changes involving the 25 msec relay settling time (a) can be completed; other logic control inputs (b) can also be changed.

$T_2 - T_1$ The $\overline{\text{Direct Command}}$ signal, which is AC coupled, must meet the following conditions:

a. Rise and fall times less than 100 μsec.

b. Signal must stay in the logical "0" state for at least 3.4 μsec. If these conditions are met, the internal read command is sustained at T_2 and the signal integrate period is started.

$T_3 - T_2$ The period of signal integration lasts for 16-2/3 msec (60 Hz line frequency; 20 msec in 50 Hz units). During this time the integrator charges to a voltage proportional to the input voltage. This is the input sampling period.

$T_4 - T_3$ During this period, the integrator is isolated from the input signal, and is discharged at a precise current. The time the integrator requires to discharge to a level equal to its voltage at T_2 is proportional to the input voltage. This time is measured by an internal counter and stored.

$T_5 - T_4$ This 1.7 μsec period is required to strobe the new reading from the internal counter into the readout latches.

$T_0 - T_5$ This 5 mseconds (±10%) is required to reset the internal logic for the next reading.

$T_1 - T_0$ If the next read command is a $\overline{\text{Direct Command}}$, this period must be made long enough to allow for the condition covered in the first cycle; however, if the next command is a $\overline{\text{Timeout Command}}$, this period can approach zero since the necessary timeout to satisfy these conditions are automatically programmed.

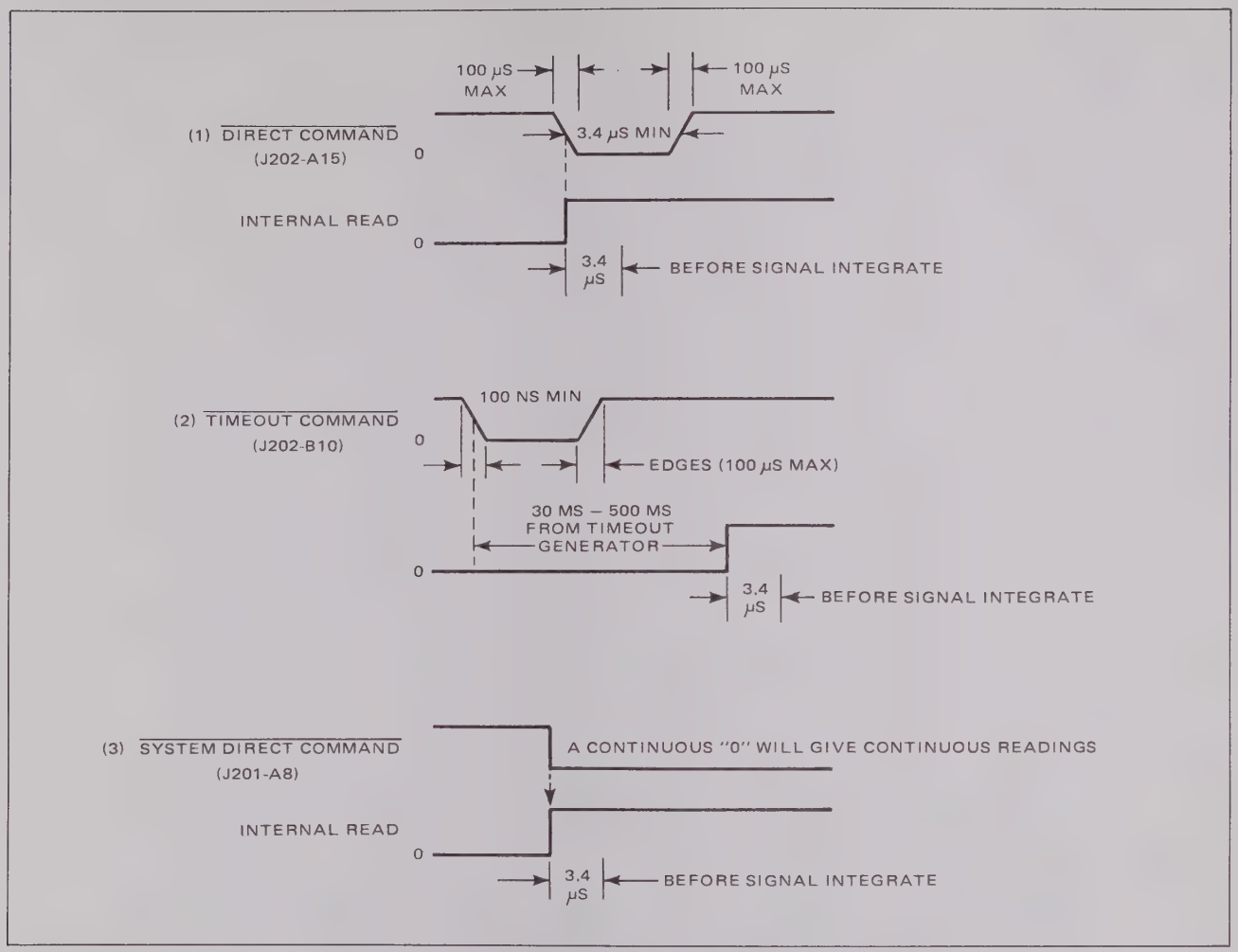


Figure 2.12 - Command Timing

2.64 Other Read Command Options.

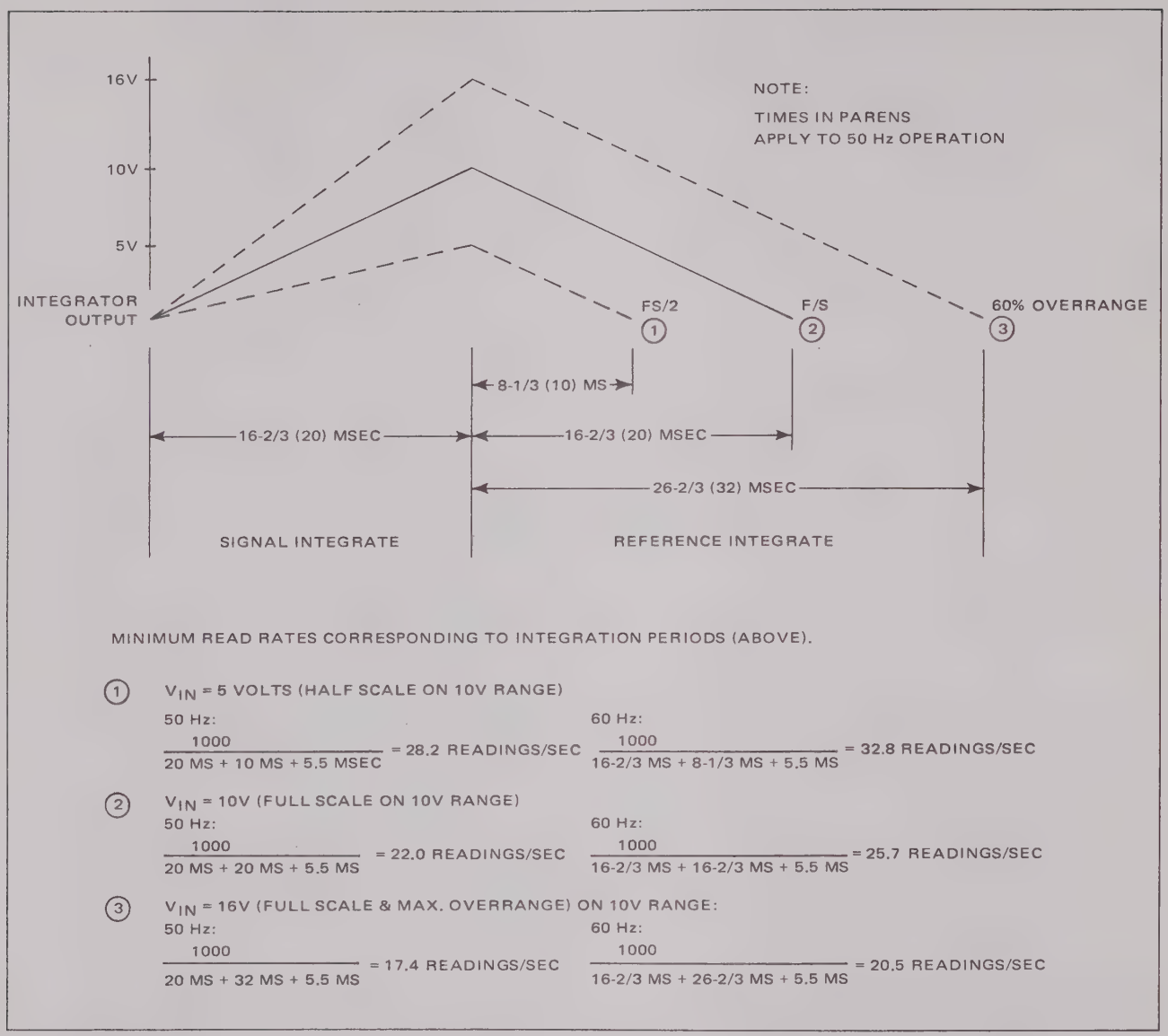
2.65 In addition to the Direct Command, there are two other programmable read commands, as illustrated in figure 2.12.

a. $\overline{\text{Time Out Command}}$: Again, this is an AC coupled input which must have rise and fall times of less than 100 µseconds but must remain in a "0" state for at least 0.1 µsecond. The timeouts given in table 2.7 for various combinations of ranges and functions ranging from 30 mseconds to 500 mseconds will be automatically inserted before the internal read command is generated. If this command is wired to the $\overline{\text{Data Ready Output}}$ on J201 - pin A11, fully automatic reading with timeouts is achieved.

NOTE

The 5 msec internal delay is not adequate for settling time on the 100 VDC, 1000 KΩ, 10 MΩ, 100 MΩ ranges, or any AC range. Therefore, the timeout command, providing timeout delays listed in table 2.7, must be used to initiate accurate readings on these ranges unless a fixed range and function have been programmed and the input has been present longer than the timeout period.

b. $\overline{\text{System Direct Command}}$: While the other two read commands were AC coupled and programmed through the Program Input Connector (J202), this command is DC coupled and programmed through



MINIMUM READ RATES CORRESPONDING TO INTEGRATION PERIODS (ABOVE).

① V_{IN} = 5 VOLTS (HALF SCALE ON 10V RANGE)

50 Hz: $\frac{1000}{20\text{ MS} + 10\text{ MS} + 5.5\text{ MSEC}}$ = 28.2 READINGS/SEC

60 Hz: $\frac{1000}{16\text{-}2/3\text{ MS} + 8\text{-}1/3\text{ MS} + 5.5\text{ MS}}$ = 32.8 READINGS/SEC

② V_{IN} = 10V (FULL SCALE ON 10V RANGE)

50 Hz: $\frac{1000}{20\text{ MS} + 20\text{ MS} + 5.5\text{ MS}}$ = 22.0 READINGS/SEC

60 Hz: $\frac{1000}{16\text{-}2/3\text{ MS} + 16\text{-}2/3\text{ MS} + 5.5\text{ MS}}$ = 25.7 READINGS/SEC

③ V_{IN} = 16V (FULL SCALE & MAX. OVERRANGE) ON 10V RANGE:

50 Hz: $\frac{1000}{20\text{ MS} + 32\text{ MS} + 5.5\text{ MS}}$ = 17.4 READINGS/SEC

60 Hz: $\frac{1000}{16\text{-}2/3\text{ MS} + 26\text{-}2/3\text{ MS} + 5.5\text{ MS}}$ = 20.5 READINGS/SEC

Figure 2.13 - Minimum Read Rate vs. Input

the Printer Output Connector (J201). The $\overline{\text{System Direct Command}}$ must remain in the "0" state for at least 3.4 μseconds to generate the internal read command. This delay, as in the $\overline{\text{Direct Command}}$, is to prevent noise from triggering the readings. If this command is tied to ground, the 5900 will recycle at its maximum reading rate with no timeouts.

2.66 Reading Rates.

2.67 In figure 2.13, integrator operation with three different input signal levels is illustrated: half scale, full scale, and 160% of full scale (full scale is defined as 100000 on any range). The figure shows that the maximum reading rate is a function of the input signal. The signal integrate period and internal reset remain fixed while the reference integrate period can vary from 0 to 32 mseconds. Therefore the maximum read rate could vary from 17.4 to 45 reading per second.

2.68 Superfast.

2.69 The Superfast reading mode (programmed through either the PRINTER OUT or PROGRAM INPUT connector)

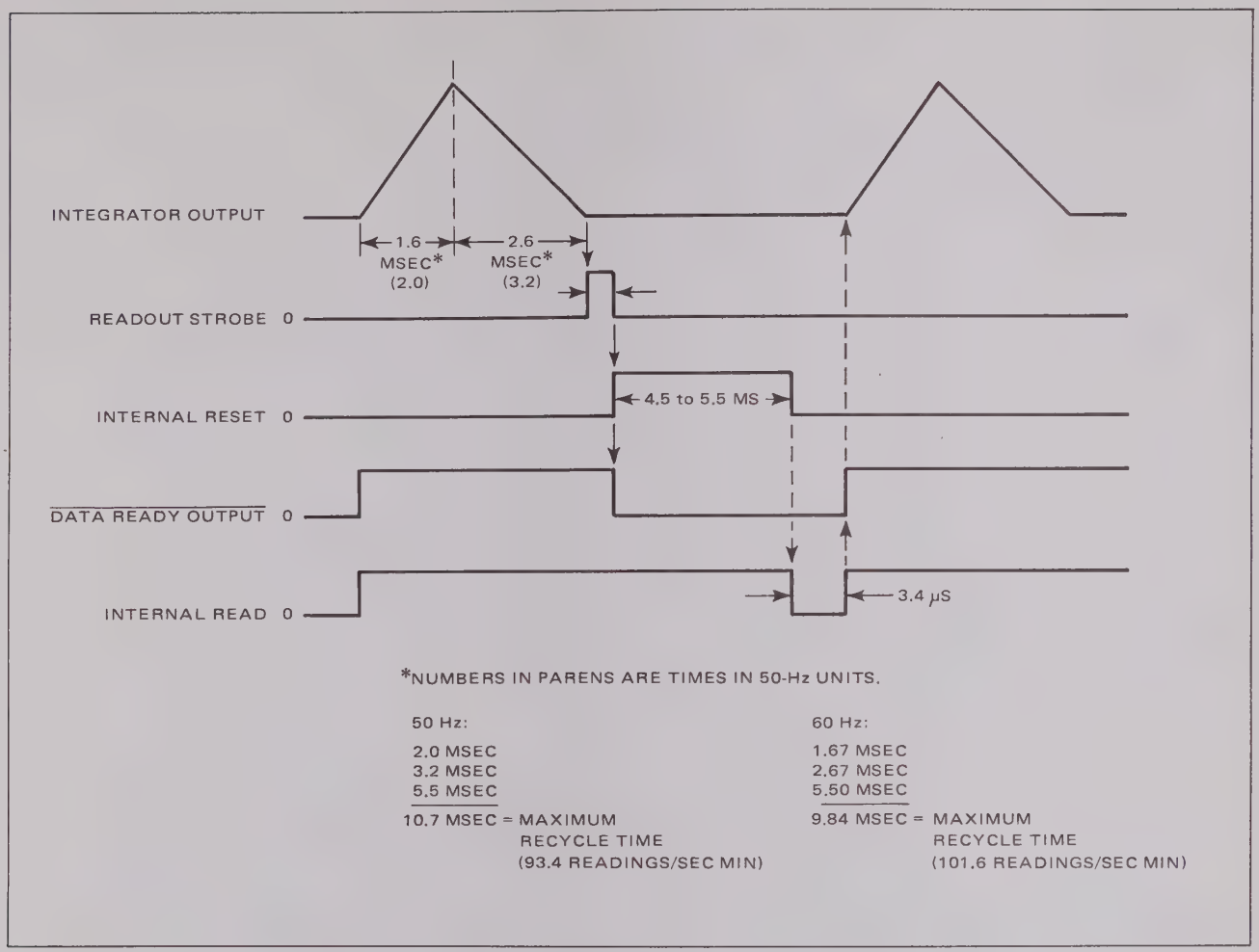


Figure 2.14 - Superfast Read Rate (Worst Case)

increases the minimum reading rate from 20.5 to 107 readings per second (50 Hz: 17.4 to 93 r/s). This is done at the expense of losing the least-significant digit which is reset to zero (blanked out on readout). The signal integration period is reduced from 16-2/3 msec to 1-2/3 msec (50 Hz: 20 msec to 2 msec). This and the resulting reference integrate period reduce the maximum recycle time from 48.8 msec to 9.8 msec (50 Hz: 57.5 msec to 10.7 msec), thereby yielding the 107 reading per second figure (93 r/s with 50 Hz). Timing changes are shown in figure 2.14.

2.70 PRINTER OUTPUT.

2.71 The printer output connector is a double-edged PCB connector (extension of Interconnection and Logic board) with pins A1 through A22 on the bottom edge and pins B1 through B22 on the top edge. Pin assignments are shown in figure 2.15. All outputs are referenced to digital ground pin B1.

2.72 Numerical Data

2.73 Numerical data appears as positive true, four-line BCD code, as shown in figure 2.15. The designator of each line identifies the digit and weight. For example: Pins A18, 19, 20, and 21 are designated 1_2, 1_8, 1_4, and 1, consecutively. The 1 indicates these lines correspond to the units or least significant display; the 2, 8, 4, and 1 subscripts indicate the binary weight of each line.

CAUTION

True output lines are not short-circuit proof. Accidental grounding may damage the output circuitry.

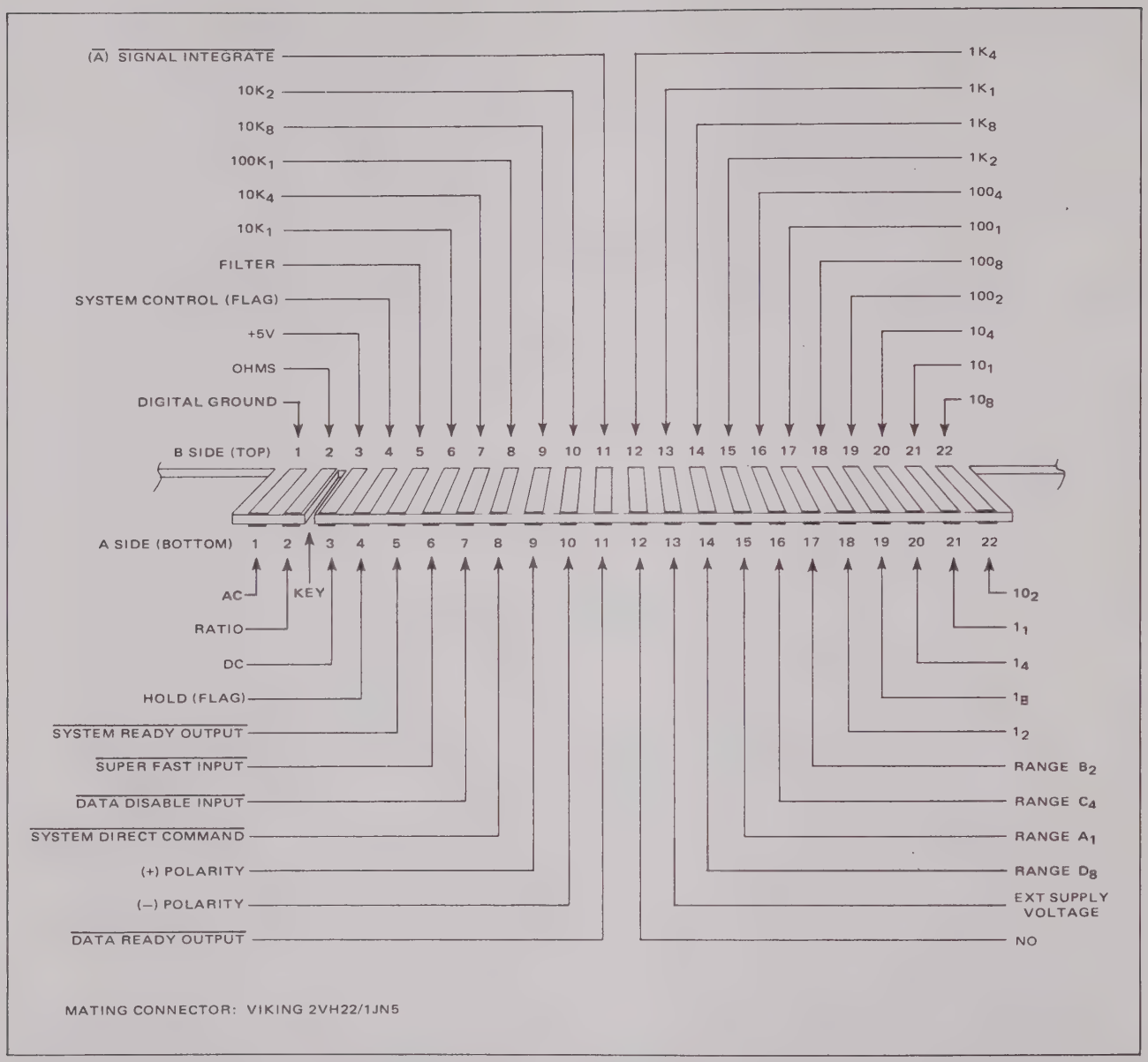


Figure 2.15 - Pin Assignments J201 PRINTER OUT

2.74 Polarity is indicated in positive true format on pin A9 (positive) and pin A10 (negative). The positive polarity line is true when the function output is AC or .1K through 1K OHMS ranges. Negative polarity is true with Ohms on the 10K through 100M ranges. If the instrument overranges, the polarity bit is not updated since no axis-crossing has occurred.

2.75 Function Data.

2.76 Function outputs appear on pins A1, 2, 3 and B2 in their true format. For example: with AC function selected, AC is true and is indicated by a true level on the corresponding line.

2.77 Range Data.

2.78 Range data appears in four-line BCD code on pins A14 through A17. Range codes are described in table 2.4.

2.79 "NO" Indication.

2.80 The NO line (pin A12) is the same as the NO indicator on the readout. The line is true if a function

Table 2.4 - Range Codes (Printer Output)

Range	$\overline{A}$ (Pin A15)	$\overline{B}$ (Pin A17)	$\overline{C}$ (Pin A16)	$\overline{D}$ (Pin A14)	Dec Value
10Ω	1	0	1	1	2
0.1V 0.1 KΩ	0	0	1	1	3
1V 1 KΩ	1	1	0	1	4
10V 10 KΩ	0	1	0	1	5
100V 100 KΩ	1	0	0	1	6
1000V 1000 KΩ	0	0	0	1	7
10 MegΩ	1	1	1	0	8
100 MegΩ	0	1	1	0	9

or range is selected for which the particular instrument is not equipped. Overrange is indicated by a true NO line plus a numerical data output of 160000.

2.81 Status Output Lines.

2.82 The following outputs indicate the status of the conversion process within the instrument.

a. $\overline{\text{DATA READY}}$. This line (pin A11) remains true during the signal and reference integration periods plus any overrange time, if required. The line drops to the false level to indicate to the printer that the measurement is complete and output data can be printed (Printer Command). With front-panel operation, $\overline{\text{DATA READY}}$ is enabled only when the DATA OUTPUT switch (on front panel) is depressed. Minimum false level time is 4.5 mseconds.

b. HOLD FLAG. A true level on this line (pin A4) indicates that the instrument is in the Hold mode. A reading can be initiated by one of the following commands:

1. $\overline{\text{SYSTEM DIRECT COMMAND}}$ (J201-A8)
2. $\overline{\text{DIRECT COMMAND}}$ (J202-A15)
3. $\overline{\text{TIMEOUT COMMAND}}$ (J202-B10)
4. RATE Control (front panel)

c. $\overline{\text{SYSTEM READY}}$. This line (pin A5) drops to a false level to indicate that the instrument can now initiate a new reading at the first available read command.

d. $\overline{\text{SIGNAL INTEGRATE}}$. This line (pin B11) becomes true at the end of the signal integration period. After this time, the input signals may be changed in preparation for the next reading. The input signal need remain constant only while the instrument is in Signal Integrate, indicated by this line in the false state. For example, the 1-2/3 msec sample time in Superfast could be used in slow sample and hold applications.

2.83 Input Control Lines.

a. $\overline{\text{DATA DISABLE}}$. A contact closure to ground or a false logic level applied to this line (pin A7) inhibits the $\overline{\text{DATA READY}}$ output (Print) pulse.

b. $\overline{\text{SYSTEM CONTROL}}$. A contact closure to ground or a false logic level on this line (pin B6) disables all front panel operating controls. Operation of the instrument is then under control of the Remote Program input. This command duplicates operation of the PROGRAM CONTROL switch on the front panel. It is necessary that one of these commands be initiated during Autorange to inhibit extra $\overline{\text{DATA READY}}$ pulses.

c. $\overline{\text{SUPERFAST}}$. A contact closure to ground or a false logic level applied to this line (J201-A6 or J202-A7) decreases the conversion time of the instrument while sacrificing the least-significant digit. This mode is described in paragraph 2.68. Because of the superfast read rate, do not use this mode with Autorange.

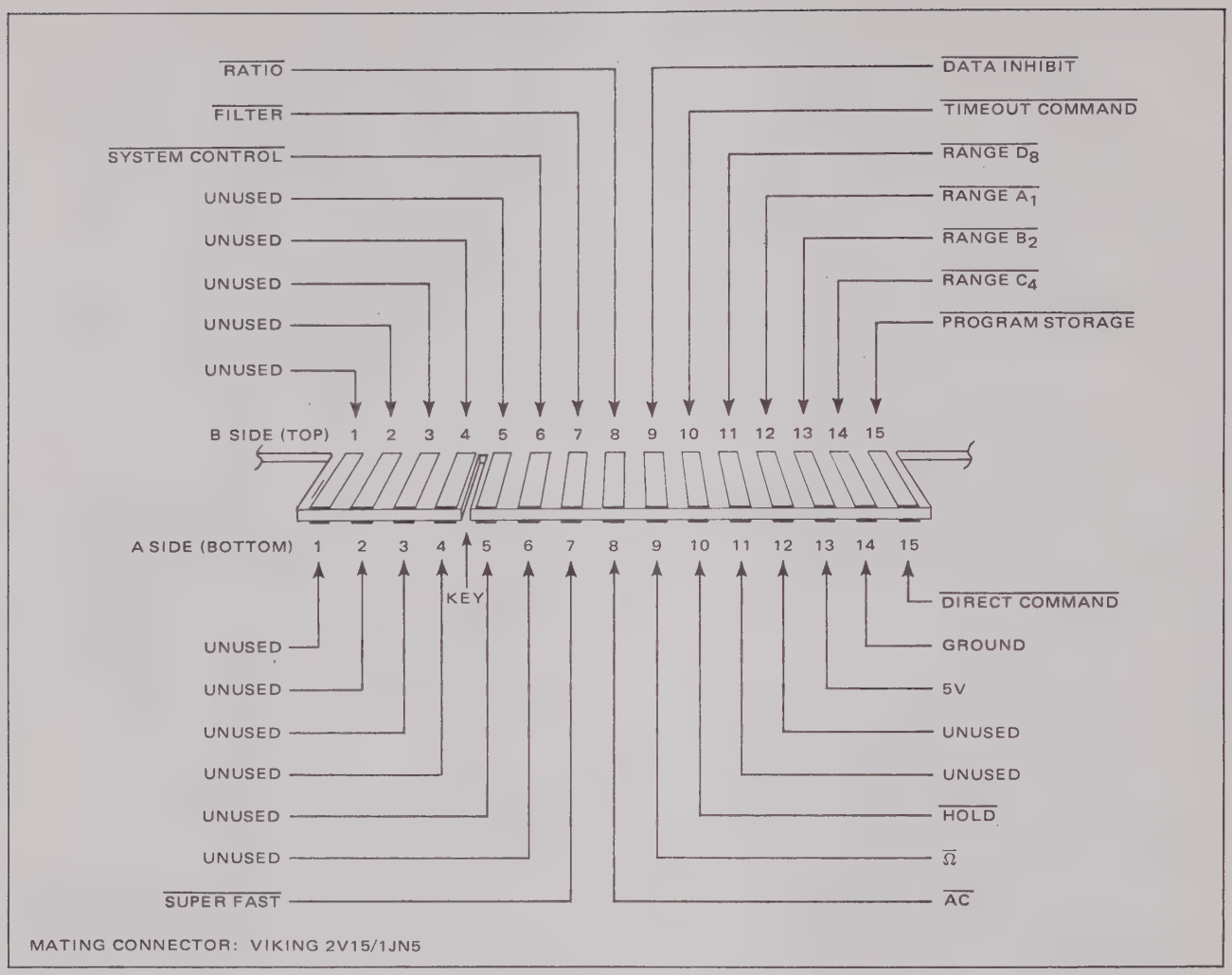


Figure 2.16 - Pin Assignments J202 PROGRAM INPUT

2.84 $\overline{\text{SYSTEM DIRECT COMMAND}}$.

2.85 To externally initiate a measurement with this command, the instrument must be in the Hold mode. Then, a contact closure to ground or a false logic level to this line (pin A8) generates a read command. Minimum false level time is 3.4 μsec. Continuous readings at the maximum read rate are obtained by tying this line to ground. Read commands delayed by 5 msec ± 10% (for settling time) are then generated automatically.

2.86 REMOTE PROGRAMMING.

2.87 The instrument accepts commands made through PROGRAM INPUT connector J202 on the rear panel. Pin assignments of J202 are shown in figure 2.16. Commands are made by a switch closure from the appropriate pin to ground or by standard TTL logic levels as described earlier.

2.88 $\overline{\text{SYSTEM CONTROL}}$.

2.89 A contact closure to ground or a false logic level applied to pin B6 disables all front panel operating controls. Operation of the instrument is then under control of the remote program input. This line duplicates the PROGRAM CONTROL switch on the front panel.

2.90 Function Programming.

2.91 The desired function is selected by applying a ground or false logic level to the appropriate pin (table 2.5).

Table 2.5 - Function Programming

$\overline{DC}$	NC
$\overline{AC}$	pin A8
$\overline{OHMS}$	pin A9
$\overline{RATIO}$	pin B8
$\overline{FILTER}$	pin B7

2.92 The 5 msecond internal delay is not adequate for settling time on the 100 VDC, 1000 Kilohm, 10 Megohm, 100 Megohm, and all AC ranges. Therefore, the timeout command, providing timeout delays listed in table 2.7, must be used to initiate readings on these ranges unless the input is fixed with range and function predetermined.

2.93 Range Programming.

2.94 Range programming is selected by applying false logic levels in BCD code to the four range lines described in table 2.6 below. With no lines programmed, Autorange is automatically selected.

2.95 + Five Volts.

2.96 This voltage, +5 volts ± 5%, from the logic power supply is available at pin A13 for external use. Current output is .1A, maximum.

2.97 Hold.

2.98 The Hold line parallels the operation of the ccw position of the front panel RATE potentiometer and is selected by a contact closure or a false logic level on pin A10. Hold is required when using either of the two read commands.

2.99 Read Commands.

2.100 Either of two read command lines can be selected by a contact closure to ground or by a negative logic level applied to the appropriate pin. Pin A15, $\overline{DIRECT\ COMMAND}$, commands a new measurement if applied after a five millisecond reset delay, and if the command is present for 3.4 μseconds. Pin B10, $\overline{TIMEOUT\ COMMAND}$, starts a new measurement after five milliseconds plus a timeout delay to allow for internal settling time of the measured signal. $\overline{TIMEOUT\ COMMAND}$ may be commanded before the previous 5 msec delay since the timeout generator stores the reading.

2.101 Timeouts.

2.102 Timeout periods for each function are listed in table 2.7. In Autorange, the indicated delays are taken following each range change.

2.103 Data Inhibit.

2.104 A contact closure or false logic level on pin B9 inhibits $\overline{DATA\ READY\ OUTPUT}$ (Print pulse) from being generated.

2.105 Program Storage.

2.106 A false level (equivalent to three TTL inputs) on pin B15 will store all the programmed inputs except the Direct and Timeout commands as they existed on the negative edge of this command (see diagram below).

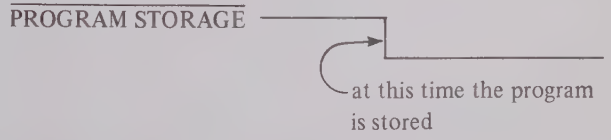


Table 2.6 - Range Codes (Programmer)

Range	$\overline{A}$ (Pin B12)	$\overline{B}$ (Pin B13)	$\overline{C}$ (Pin B14)	$\overline{D}$ (Pin B11)	Dec Value
AUTO	1	1	1	1	0
10Ω	1	0	1	1	2
0.1V 0.1 KΩ	0	0	1	1	3
1V 1 KΩ	1	1	0	1	4
10V 10 KΩ	0	1	0	1	5
100V 100 KΩ	1	0	0	1	6
1000V 1000 KΩ	0	0	0	1	7
10 MegΩ	1	1	1	0	8
100 MegΩ	0	1	1	0	9

2.107 SUPERFAST.

2.108 A contact closure to ground or a false logic level applied to pin A7 decreases the signal integrate and the reference integrate times (see paragraph 2.68). This provides the maximum reading rate in the Direct COMMAND mode of operation. Because of the high reading rate, Superfast must be programmed with a fixed range rather than AUTORANGE.

Table 2.7 - Timeouts

DC	30 msec
1 Ohm to 1 Megohm	30 msec
10 Meg*	30 msec
100 Megohm	300 msec
Filter	470 msec (plus function timeout)
AC(fixed range, no filter)	180 msec
AC+Filter(&Autorange)	650 msec
*Use filter for <.01% error	

Table 2.8 - Maximum Input Voltage

CAUTION Do not exceed the following maximum inputs.	
DC	1000 VDC or RMS AC All ranges
AC	1000 RMS to 20 kHz decreasing 20 dB/ decade to 20V RMS at 1 MHz
RATIO	Input: same as function selected Reference: +10.5V, –0.5V
OHMS	±500V DC or Peak AC
GUARD	Voltage between GUARD AND – INPUT must not exceed 500 volts or damage to the instrument may result

SECTION 3 SPECIFICATION TESTS

3.1 GENERAL.

3.2 This procedure is designed to insure that the instrument is operating properly and within its specifications. If any of the readings are not within tolerance, refer to the calibration procedure. If the instrument fails to operate properly, refer to the troubleshooting procedure.

3.3 PREPARATION.

3.4 Allow one hour warmup time for the instrument to reach full accuracy.

3.5 EQUIPMENT.

3.6 A list of equipment is provided in table 3.1.

3.7 PROCEDURE.

3.8 Connect the DVM and test equipment as shown in the figure supplied with each accuracy check. Select the controls and inputs as called out in the tables and monitor the DVM readout for the indicated values.

Table 3.1 - Required Equipment

TYPE	REQUIRED SPECS	SUGGESTED EQUIPMENT
DC Voltage Standard	Adjustable: 0 to 1000V RMS Resolution: 1 μV on 10V range Accuracy: ±.0003%	Fluke 332A Corrected to accuracy required
Decade Voltage Divider	.0001% Accuracy	Fluke 720A
AC Laboratory power source	Variable: 0 to 500V RMS & 20 Hz to 100 KHz. Resolution better than 100 PPM. Harmonic distortion of 0.1% or less. Stability of .003%	HP 745/746
Thermal Transfer voltmeter [1]	AC/DC thermal transfer voltmeter. Ranges: 1 to 500V. Accuracy .01% or better	Holt Model 6 Thermal Transfer Voltmeter
Standard Resistors [2]	10Ω; .001% 100Ω through 1 MΩ; .0005% 10 MΩ; .002% 100 MΩ; .01%	ESI SR-1 series standard resistors
1/4W Carbon Resistors	10, 100 Kohm and 100 Ohm	
Capacitor	1 μF (non polar)	
Batteries, 2 required	1.5V cells having screw type binding posts	

[1] Required for instruments equipped with AC Option only

[2] Required for instruments equipped with OHMS Option only

Table 3.2 - DC Range Check (Low Ranges)

DVM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	DC VOLTAGE STANDARD	DIVIDER SETTING			
DC	.1V	10.00000	.01000	.100000	.099992 – .100008	23°C ± 5°C (After zeroing)
	1V	10.00000	.10000	1.00000	0.99997 – 1.00003	

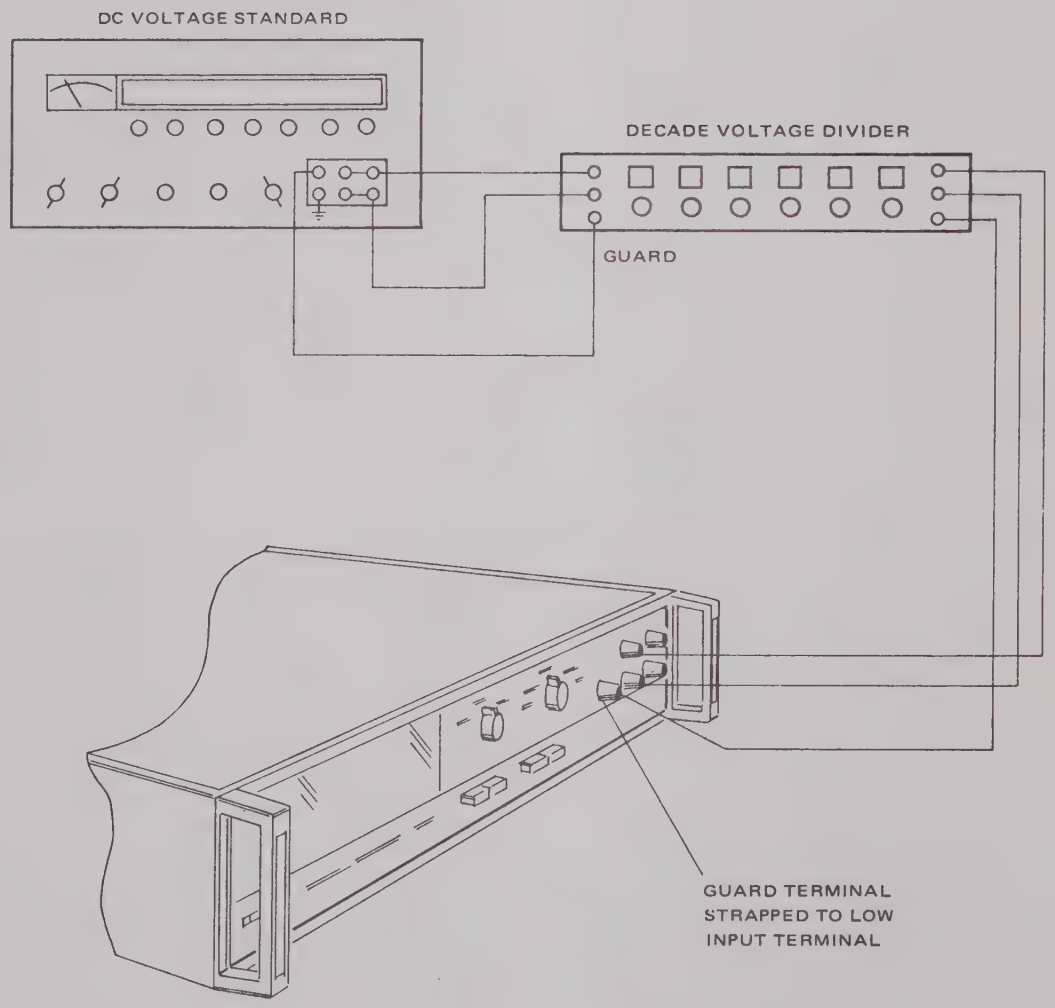


Table 3.3 - DC Range Check (High Ranges)

DVM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	DC VOLTAGE STANDARD				
DC	10	10.0000V		10.000	9.9998 – 10.0002	$23^{o}C \pm 5^{o}C$ (After zeroing)
	100	100.000V		100.00	99.997 – 100.003	
	1000	1000.00V		1000.0	999.97 – 1000.03	

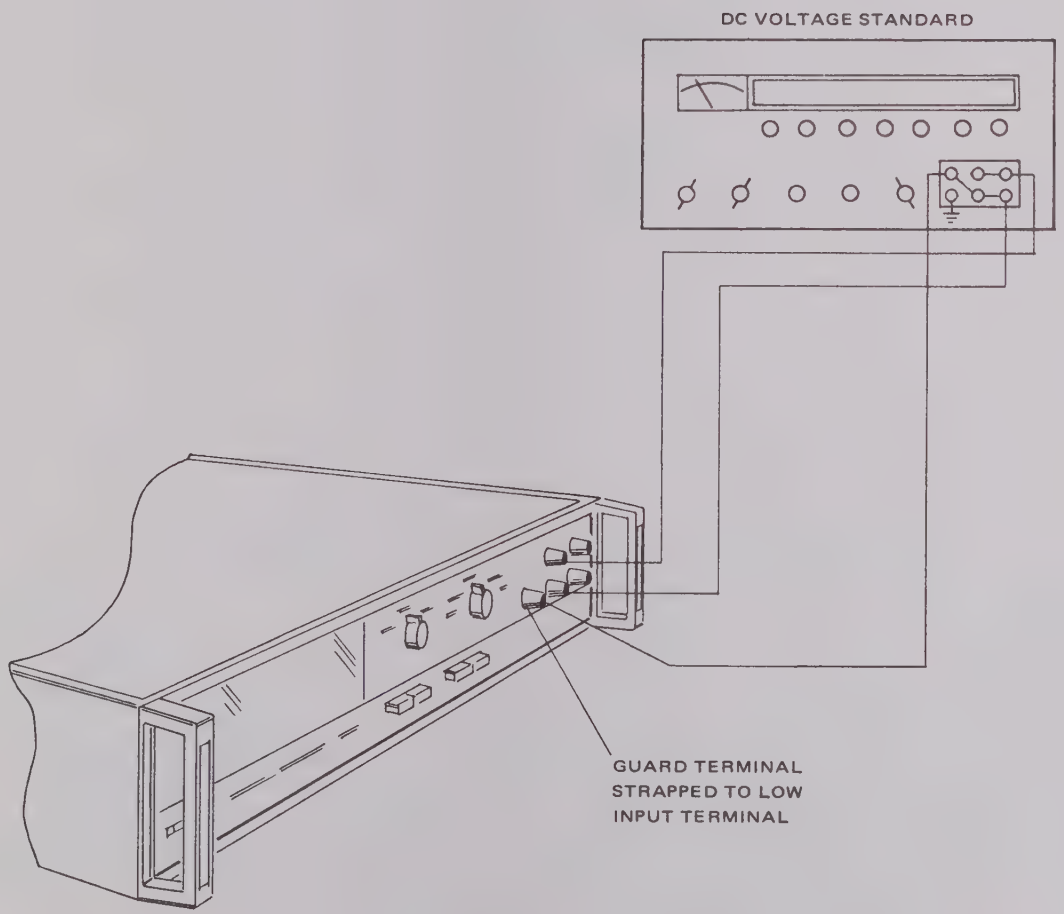


Table 3.4 - 3-Wire Ratio Check

DVM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	DC VOLTAGE STANDARD				
DC	10	+ 2.00000V		10.000	9.9990 – 10.0010	23°C ± 5°C (After zeroing)
RATIO		+10.00000V		10.000	9.9998 – 10.0002	

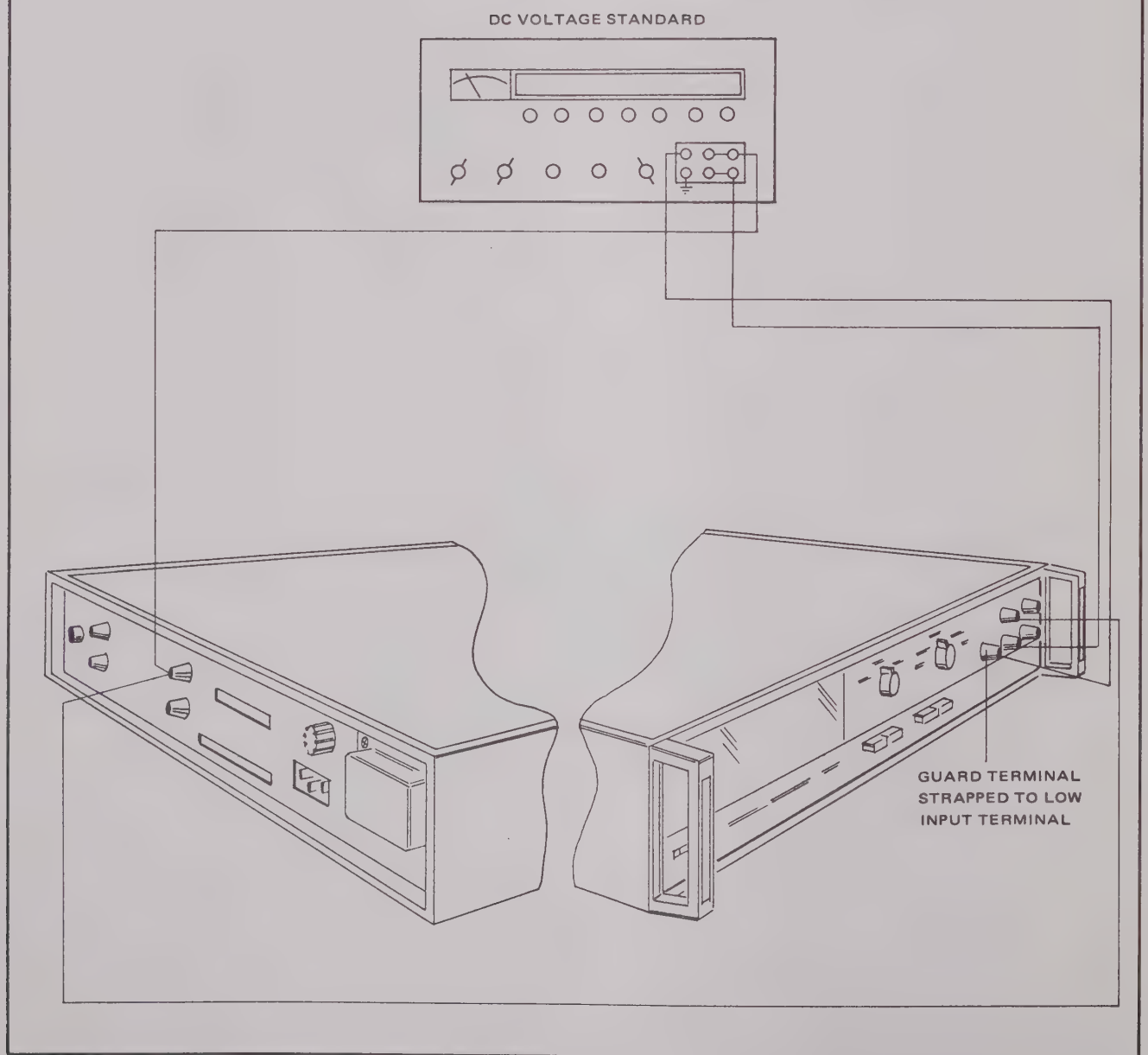


Table 3.5 - 4-Wire Ratio Check

DVM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	DC VOLTAGE STANDARD				
DC	10	+ 2.00000V		+10.0000	9.9980 – 10.0020	23°C ± 5°C (After zeroing)
RATIO	10	+10.00000V		+10.0000	9.9996 – 10.0004	
		–10.00000V		+10.0000	9.9996 – 10.0004	

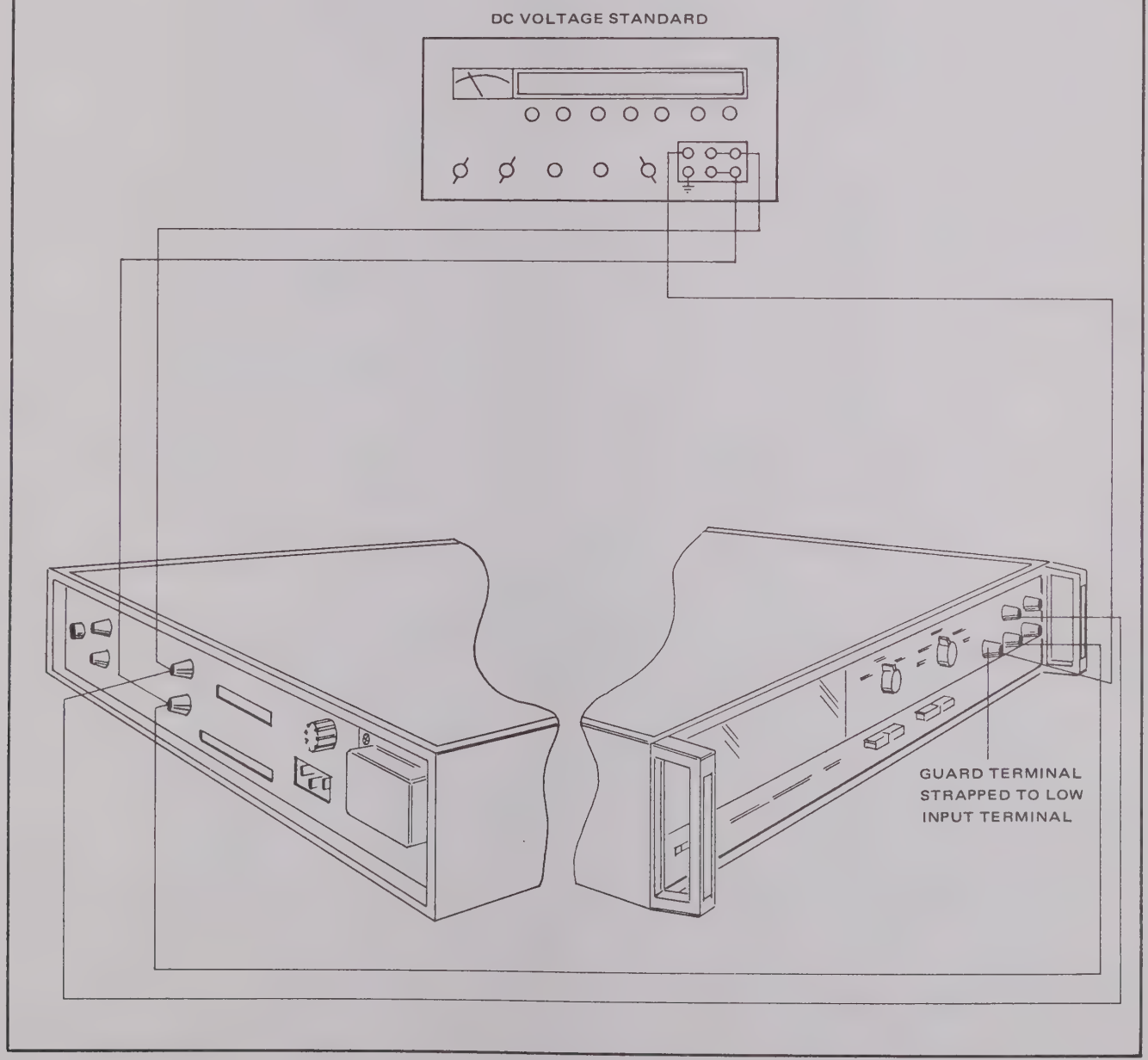


Table 3.6 - DC Input Resistance

DVM		INPUT SIGNAL		DVM DISPLAY	TOLERANCE	NOTE
FUNCTION	RANGE	DC VOLTS*	S1			
DC	0.1	.100000	Closed	.10000		Rs
			Open		.09998 - .10002	1 Meg
	1	1.000000	Closed	1.0000		
			Open		0.9999 - 1.0001	1 Meg
	10	10.00000	Closed	10.000		
			Open		9.999 - 10.001	1 Meg
	100	100.0000	Closed	100.00		
			Open		99.99 - 100.01	1 K
	1000	1000.000	Closed	1000.0		
			Open		999.9 - 1000.1	1 K
						*Adjust the DC Voltage Standard to produce the DVM DISPLAY reading.

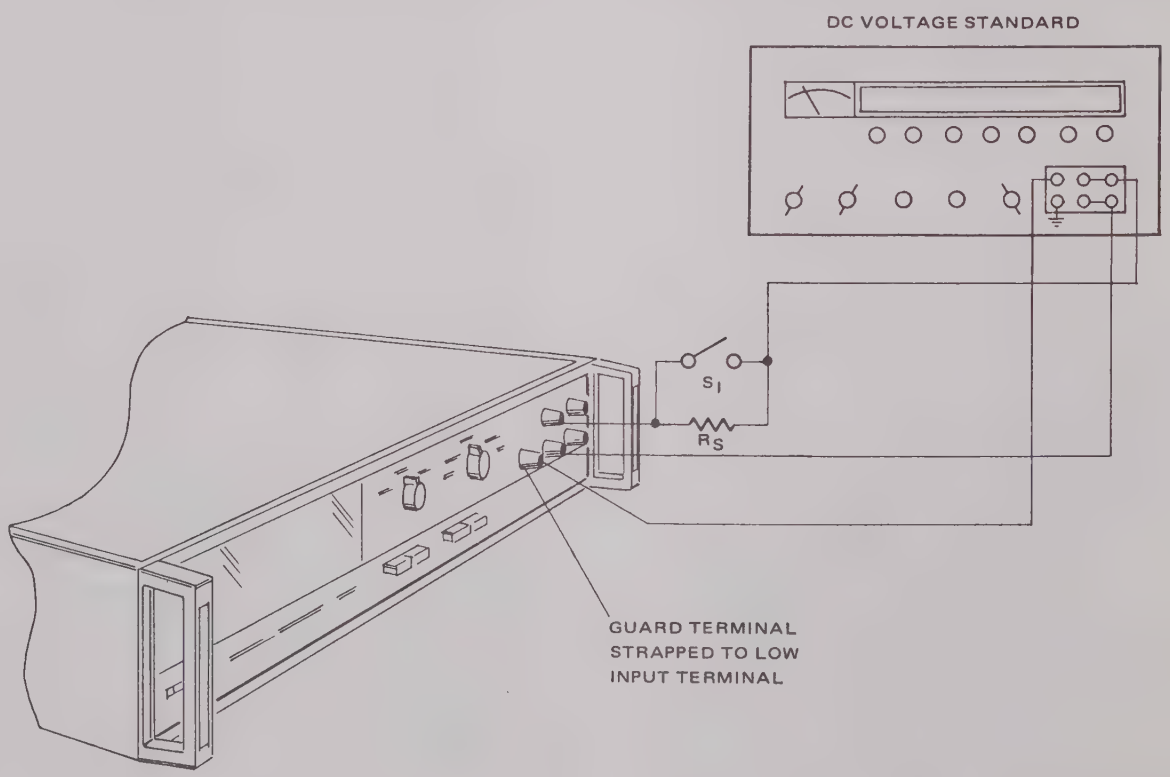


Table 3.7 - AC Range Check

DVM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	DC VOLTAGE STANDARD	AC			
AC	1	1.000000	1.V, 10 KHz	1.0000	0.99968 – 1.00032	Set thermal transfer voltmeter to same range as the DMM Adjust the amplitude controls on the AC source to produce a Null on the thermal transfer voltmeter, for each new setting 23°C ± 5°C
		1.000000	1.V, 50 KHz	1.0000	0.99965 – 1.00035	
	10	10.00000	10V, 10 KHz	10.000	9.9968 – 10.0032	
		10.00000	10V, 50 KHz	10.000	9.9965 – 10.0035	
	100	100.0000	100V, 10 KHz	100.00	99.968 – 100.032	
		100.0000	100V, 50 KHz	100.00	99.965 – 100.035	
	1000	125.0000	125V, 10 KHz	125.00	124.94 – 125.06	
		125.0000	125V, 50 KHz	125.00	124.91 – 125.09	

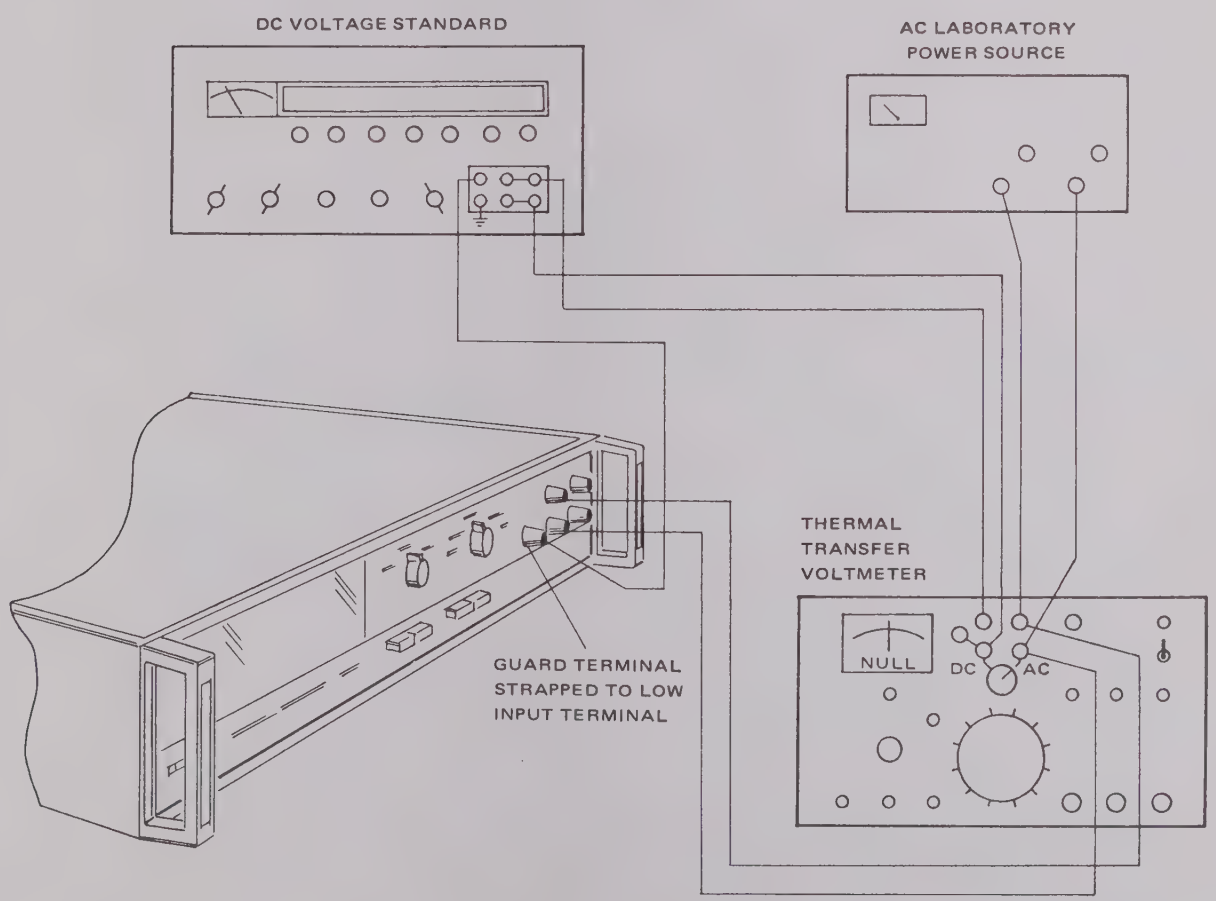


Table 3.8 - Ohms-Megohms Range Check

DVM		INPUT SIGNAL		NOMINAL READING (Same as Standard)	TOLERANCE
FUNCTION	RANGE	NOMINAL STANDARD VALUE	TOLERANCE		
Ω - MΩ	10Ω	10Ω	.001%		±10 digits
	100Ω	100Ω	.0005%		±4 digits
	1 kΩ	1 kΩ	.0005%		±4 digits
	10 kΩ	10 kΩ	.0005%		±4 digits
	100 kΩ	100 kΩ	.0005%		±4 digits
	1 MΩ	1 MΩ	.0005%		±4 digits
	10 MΩ	10 MΩ	.002%		±31 digits
	100 MΩ	100 MΩ	.01%		±51 digits

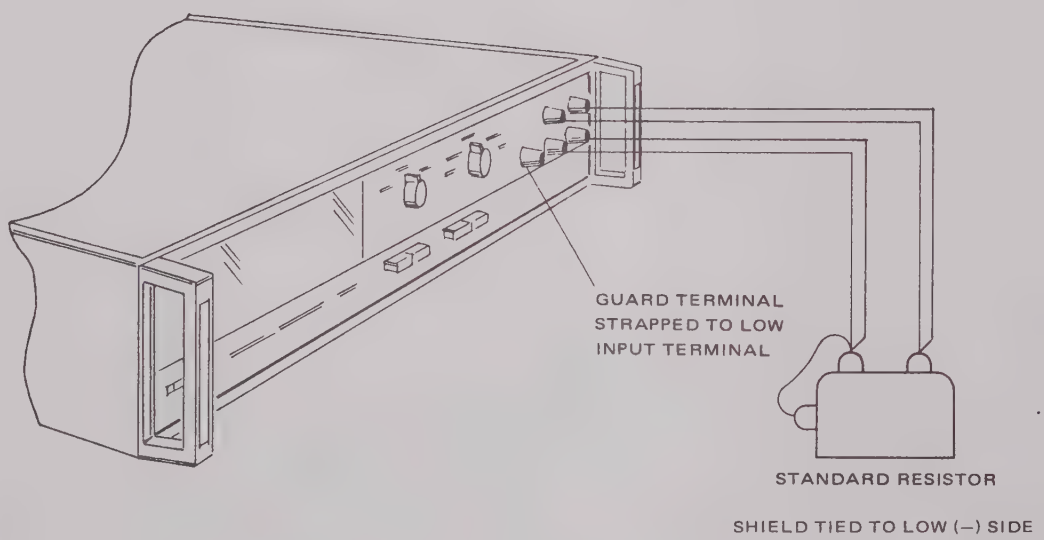


Table 3.9 - Common Mode Rejection (In DC Volts Function)

DVM		INPUT SIGNAL		NOMINAL READING See Note 1	TOLERANCE	NOTE
FUNCTION	RANGE	S1				
DCV FILT. OUT	0.1	Off			±1 digit from nominal	1) With switch S-1 in the off position, record the reading displayed on the DMM's readout in the "nominal reading" boxes of the table.
		DC			±5 digits from nominal	
		AC			±25 digits from nominal	
DCV FILT. IN	0.1	DC			±50 digits from nominal	
		AC			±25 digits from nominal	

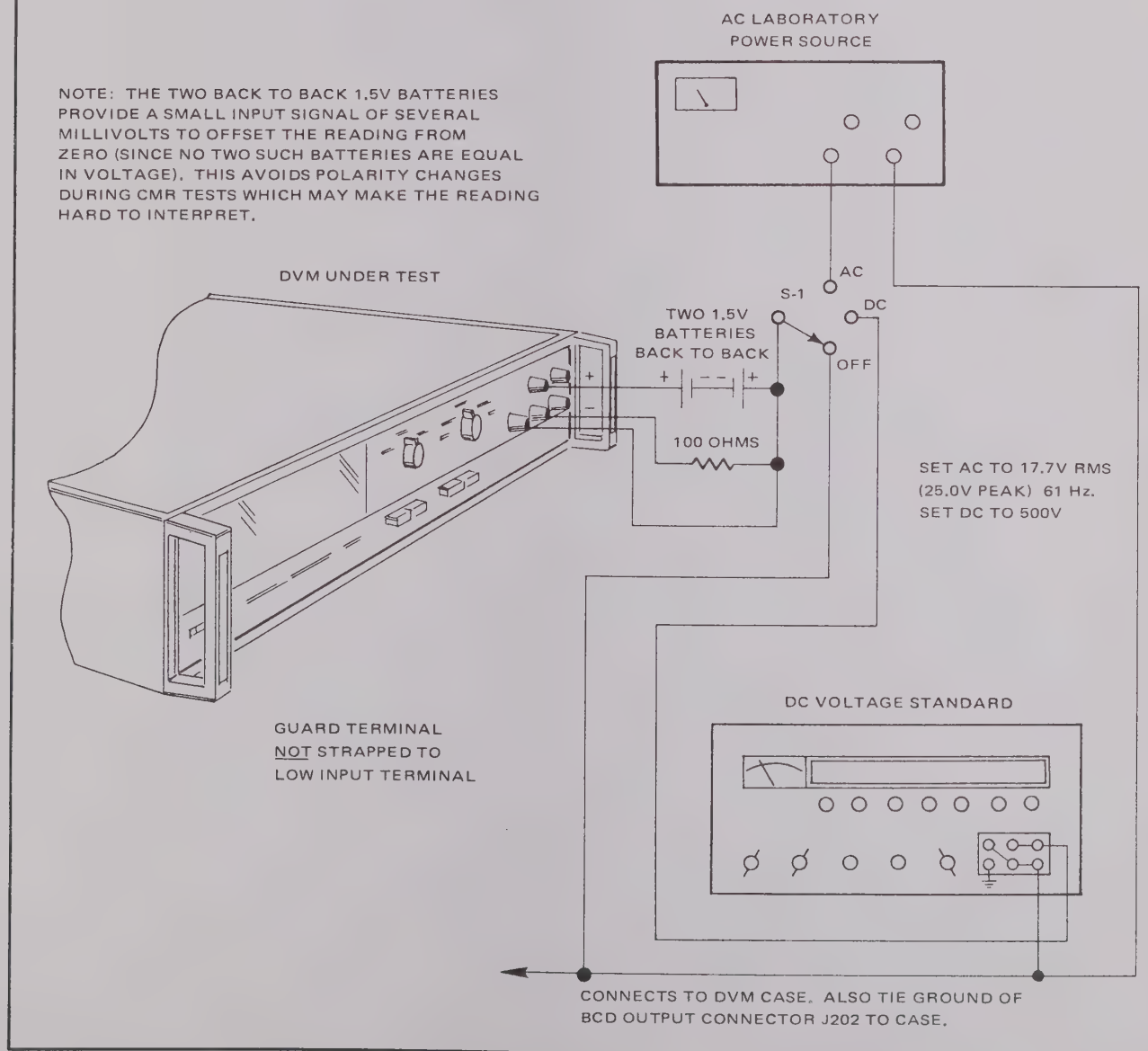

AC LABORATORY POWER SOURCE
NOTE: THE TWO BACK TO BACK 1.5V BATTERIES PROVIDE A SMALL INPUT SIGNAL OF SEVERAL MILLIVOLTS TO OFFSET THE READING FROM ZERO (SINCE NO TWO SUCH BATTERIES ARE EQUAL IN VOLTAGE). THIS AVOIDS POLARITY CHANGES DURING CMR TESTS WHICH MAY MAKE THE READING HARD TO INTERPRET.
DVM UNDER TEST
AC
S-1
DC
TWO 1.5V BATTERIES BACK TO BACK
OFF
100 OHMS
SET AC TO 17.7V RMS (25.0V PEAK) 61 Hz.
SET DC TO 500V
DC VOLTAGE STANDARD
GUARD TERMINAL NOT STRAPPED TO LOW INPUT TERMINAL
CONNECTS TO DVM CASE. ALSO TIE GROUND OF BCD OUTPUT CONNECTOR J202 TO CASE.

Table 3.10 - Normal Mode Noise Rejection (In DC Volts Function)

DVM		INPUT SIGNAL		NOMINAL READING	TOLERANCE	NOTE
FUNCTION	RANGE	DC	AC			
DC FILT. OUT	10	0.5V	10V*, 60 Hz	00.500	±200 digits	
FILT. IN	1V	0.5V	10V*, 60 Hz	0.5000	±10 digits	

*peak

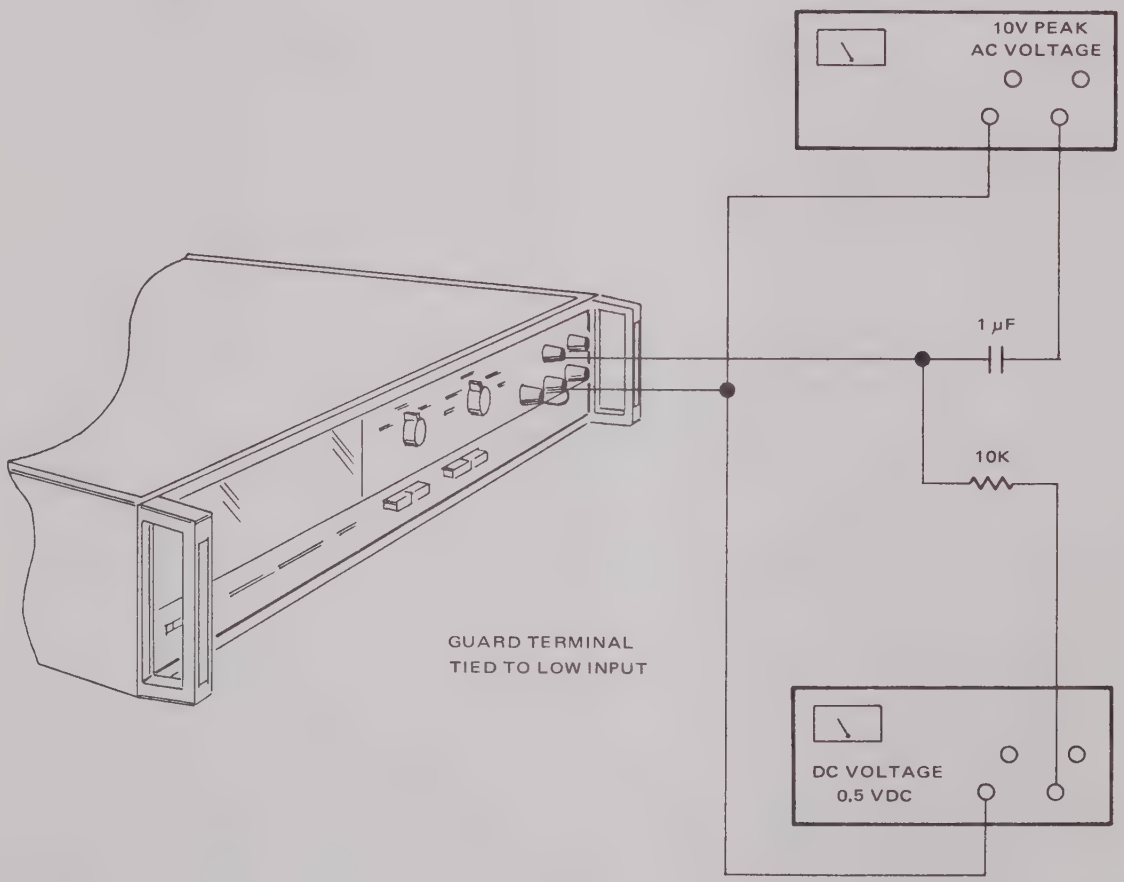
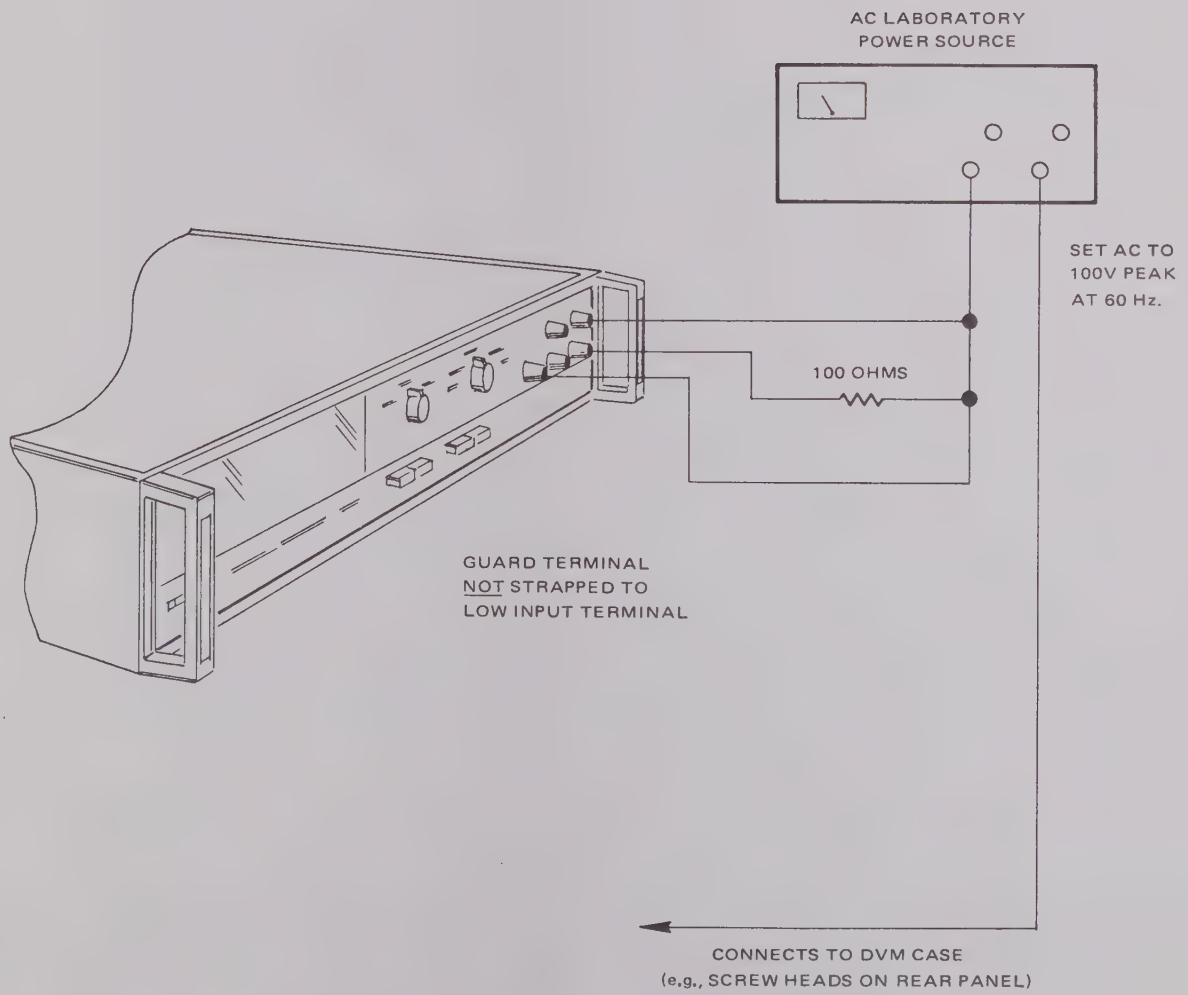


Table 3.11 - Common Mode Rejection (In AC Volts Function)

DVM		COMMON MODE INPUT SIGNAL		NOMINAL READING (see note)	TOLERANCE	NOTE
FUNCTION	RANGE	VOLTAGE	FREQ.			
AC	1	100V Peak	60 Hz		±10 digits	Enter reading with shorted input in nominal column before beginning
	10	100V Peak	60 Hz		±1 digit	
	100	100V Peak	60 Hz		±1 digit	
	1000	100V Peak	60 Hz		±1 digit	



4.1 GENERAL.

4.2 This section describes the operation of the main circuitry of the Model 5900 DVM, briefly covering the mechanical organization and then the electrical operation of the instrument. The simplified drawings provided in this section are for the purpose of illustration, and supplement the complete schematics of Section 6.

4.3 MECHANICAL DESCRIPTION.

4.4 The Model 5900, shown in figure 4.1, consists of a large, single, printed circuit Logic and Interconnection board (Main Logic) with as many as 12 separate PC boards plugging directly or indirectly (by means of cables) into the Main Logic board. The electronics are housed in a sturdy die cast and stamped aluminum package with the readout, input terminals, and all manual controls located on the front panel. On the back panel is located the power cable input, all data output, optional remote input, analog output, external reference, and optional rear inputs.

4.5 ELECTRICAL DESCRIPTION.

4.6 The instrument is divided into three functional groups. These are the Signal Conditioning section, the Analog-to-Digital Conversion section, and the Display/ Control Logic section.

4.7 SIGNAL CONDITIONING SECTION.

4.8 The Signal Conditioning section for a fully equipped instrument consists of: the Switching Board, the Ohms Converter, the Averaging AC Converter or the RMS AC Converter, the Attenuator, and the Isolator. The basic instrument consists of the Switching Bypass Board, the Attenuator, and the Isolator.

4.9 The Signal Conditioning section routes, scales, filters and, when required, converts the input signal into a stable 10 volt full scale dc level for use by the measurement portion of the DVM.

4.10 Switching Board.

4.11 The Switching board is a single printed circuit board and occupies connectors J5 and J6 on the Main Logic board. The Switching board is used with instruments equipped with either the Ohms Converter or either of the available ac converters and is necessary for the generation and isolation of range data and for signal routing required by the options. The interconnection of the Switching board with the options and the other components of the Signal Conditioning section is shown in block diagram form in figure 4.2.

4.12 The control of signal flow through the Switching board, shown in simplified form in figure 4.3, is by means of two relays K1 and K2. The three possible signal routes provided by the board are illustrated in figure 4.4. Referring to this figure, with the dc function selected, neither of the relays is energized and the signal flow is as shown in (a); with the ac function selected, relay K1 is energized and the signal flow is as shown in (b); with ohms function selected, relay K2 is energized and the signal flow is as shown in (c).

4.13 The range control of the option boards uses analog supply voltages and require isolation from the digital supplies and decoding. This is provided on the Switching board by three Optically Coupled Isolators (OCI) and a BCD to TEN line driver. The decoding of the range logic is given in table 4.1.

Table 4.1 - Switching Board Range Decode

INPUT CODE			WEIGHT	OUTPUT CODE							
RANGE				U2 PIN NO.							RANGE
A_1	B_2	C_4		8	9	13	14	11	10	16	
L	H	L	2	L	H	H	H	H	H	H	.01
H	H	L	3	H	L	H	H	H	H	H	.1
L	L	H	4	H	H	L	H	H	H	H	1
H	L	H	5	H	H	H	L	H	H	H	10
L	H	H	6	H	H	H	H	L	H	H	100
H	H	H	7	H	H	H	H	H	L	H	1000
L	L	L	0	H	H	H	H	H	H	L	10,000

4.14 Ohms Converter.

4.15 The Ohms Converter circuitry is mounted on a single printed circuit board and occupies connector J10 on the Main Logic board. The circuitry, shown simplified in figure 4.5, consists of a high gain amplifier and a relay operated positive current source that is capable of producing any one of eight precise current levels depending on the range selected.

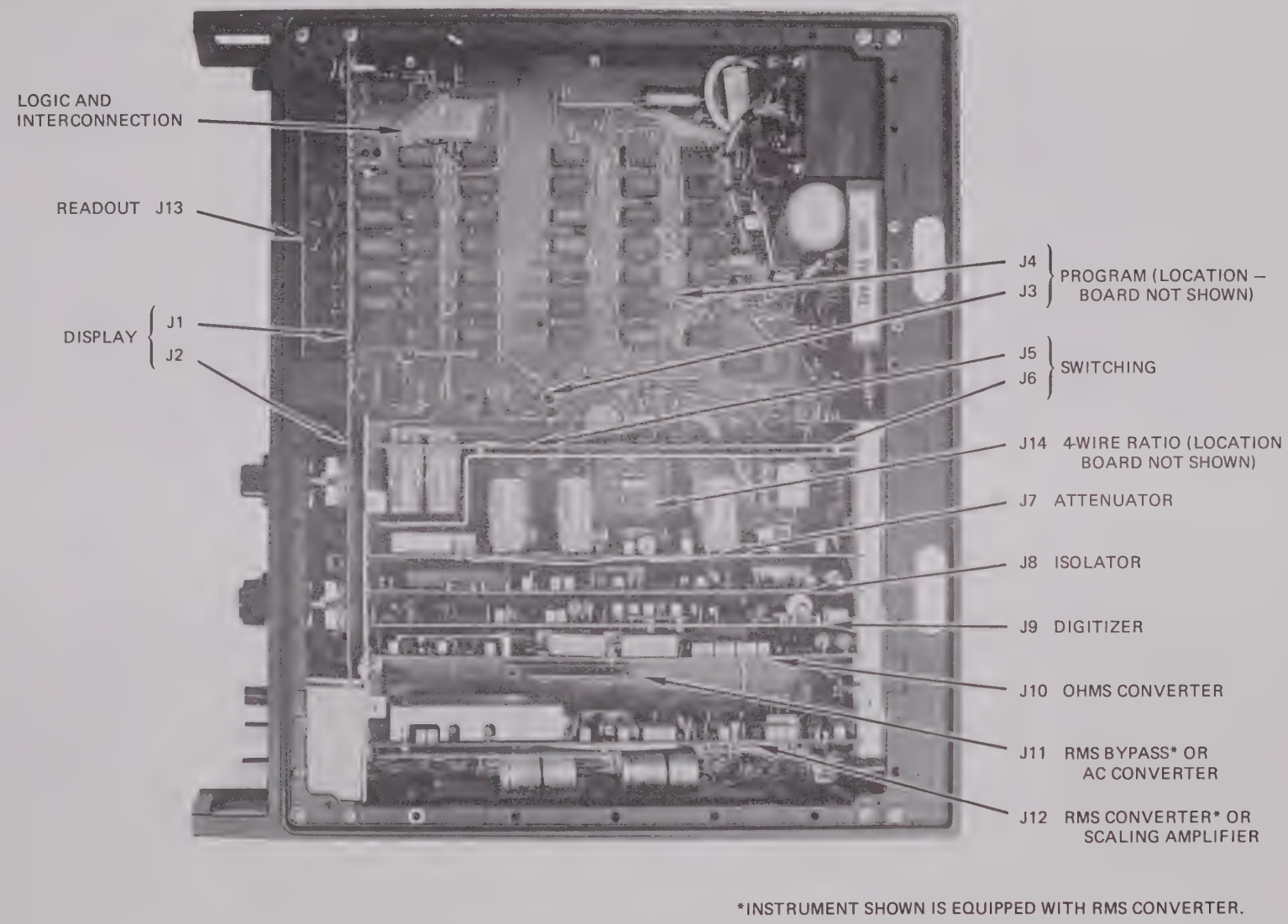


Figure 4.1 - Mechanical Assembly

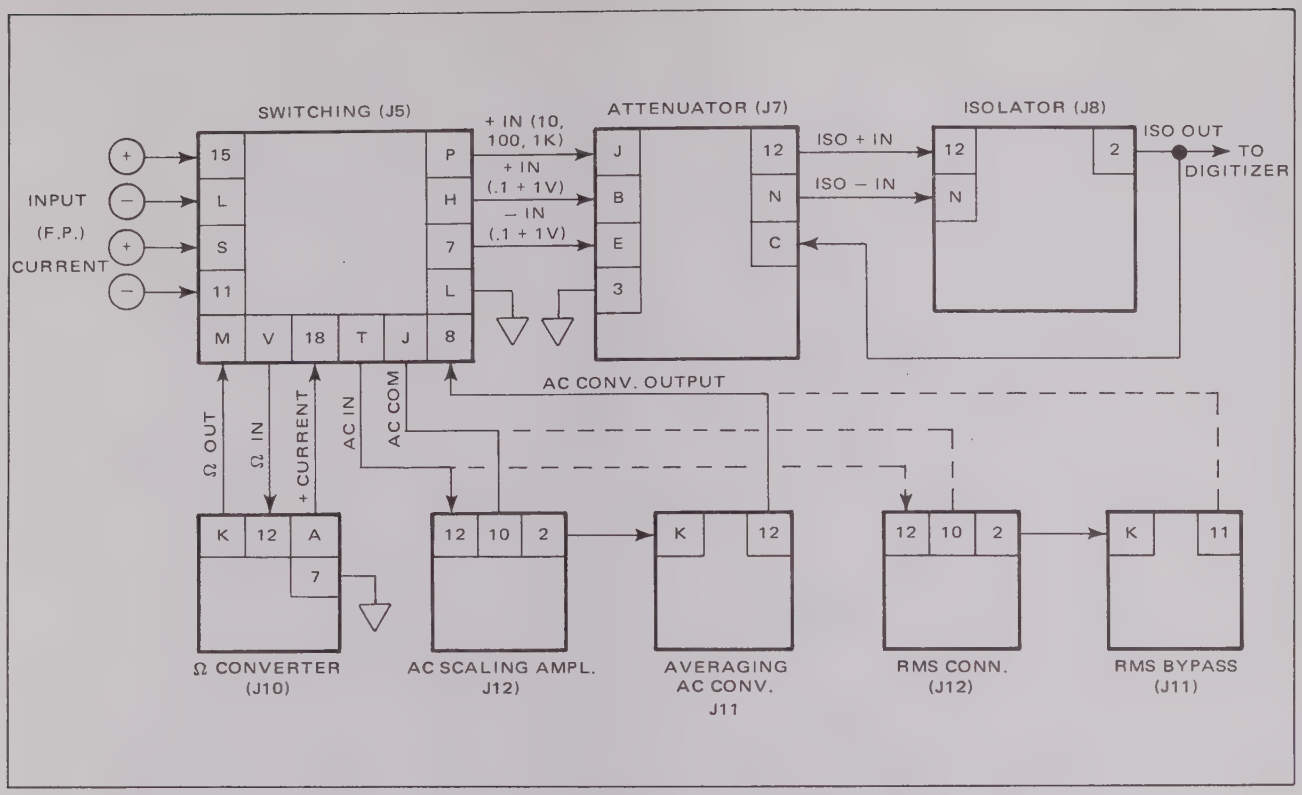


Figure 4.2 - Signal Flow, Loaded DVM

4.16 The Ohms Converter, in conjunction with the Switching board, the Attenuator, and the Isolator, converts the resistance to be measured into a proportional dc voltage that can be measured by the DVM. The current produced for each range, when applied to a resistance equal to the range selected, generates a voltage at the output of the resistance measurement network of 10 volts.

4.17 The resistance measurement network assumes two forms, depending on the range being measured, as shown in figure 4.6. The basic technique used consists of effectively connecting the resistance to be measured (Rx) as a negative feedback path of an operational amplifier, with the amplifier provided by the Ohms Converter and the input to the operational amplifier formed by the current generator. In this hookup, the current through Rx equals the current generated by the current source. Referring to configuration (a), used for the ranges 10 kilohm through 100 megohm, the voltage developed across Rx is monitored through the – IN front panel connector and buffered by the isolator in a gain-of-one mode. The full scale output for these ranges, as shown in the table, is –10 volts. Referring to figure (b), the isolator is connected in a potentiometric configuration but with the input at an effective ground potential and the reference end of the feedback network tied to the voltage developed across Rx. The low impedance provided by the isolator feedback network is offset by the current compensation circuit (c.c.). This circuit monitors the output potential of the isolator and produces a current drain precisely equal to the current produced by the feedback network. The result is that the feedback network appears to have an extremely high input impedance. The configuration used in (b) reduces normal the gain of the isolator by 1, thereby producing gains of 99 and 9 as shown in the table.

4.18 Scaling Amplifier.

4.19 The Scaling Amplifier, shown simplified in figure 4.7, is used in conjunction with the Averaging AC Converter and occupies position J12. It provides isolation between the signal being measured and the signal converting circuitry and it scales the input signal to a level suitable for the converter (1V RMS output for a full scale input).

4.20 The Scaling Amplifier consists of an AC coupled operational amplifier with four possible gain settings (X1, X.1, X.01, and X.001). The gain control network is controlled by three relays and these are operated from decoded data from the range logic. A change in the roll off of the amplifier is provided when the 1 volt range is selected.

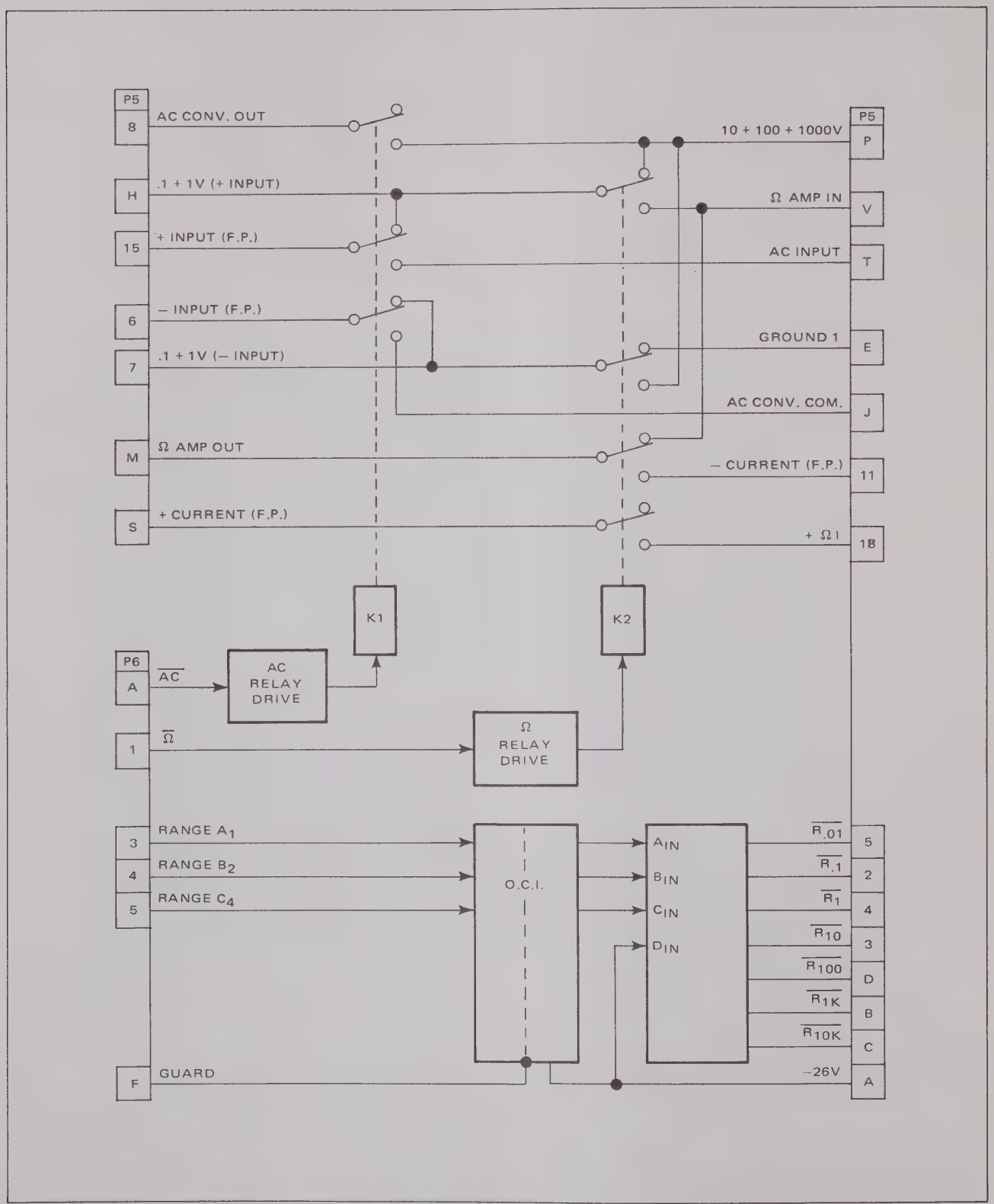
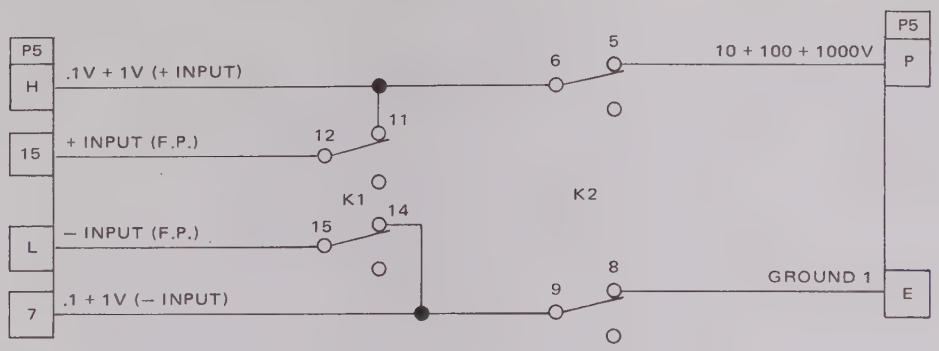
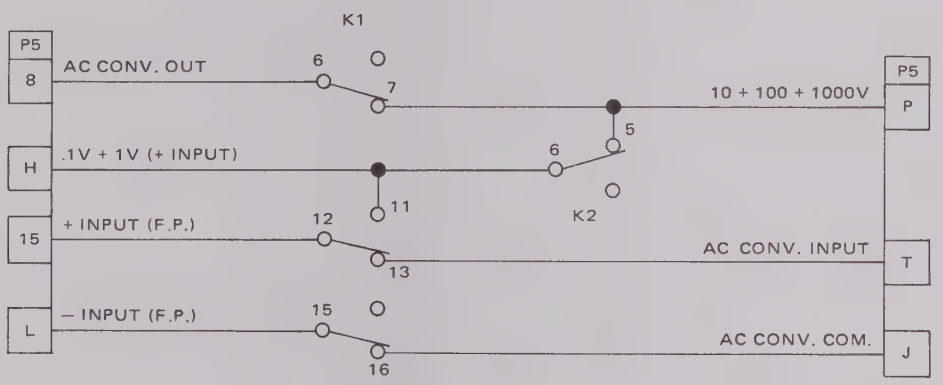


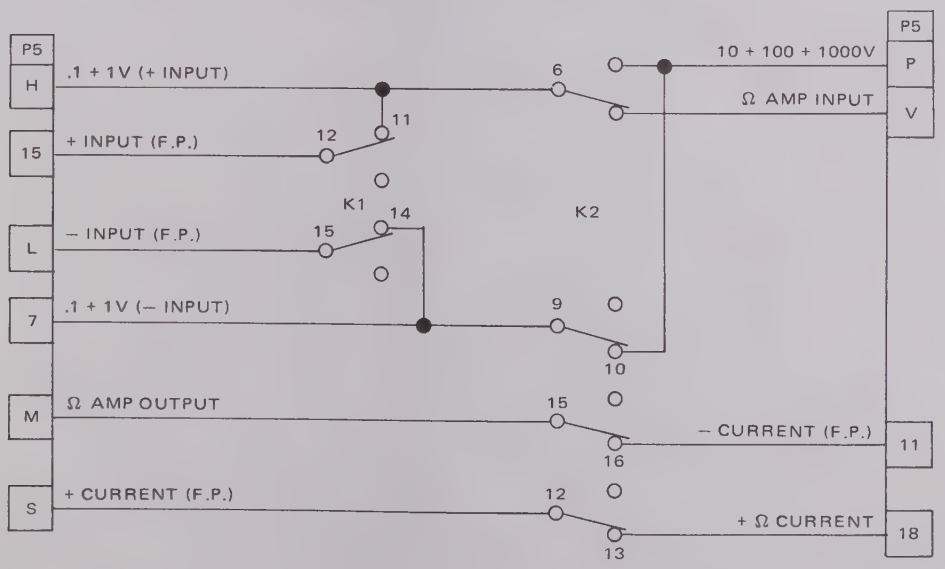
Figure 4.3 - Switching Board



(a) DC Routing

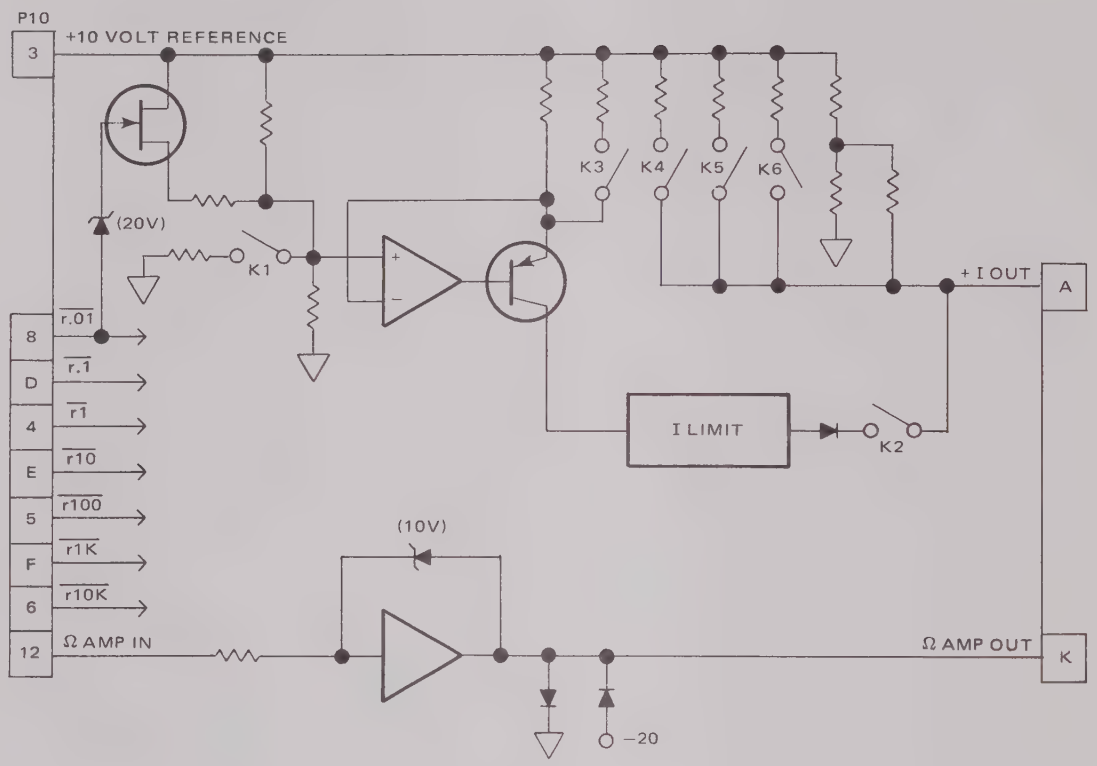


(b) AC Routing



(c) Ω Routing

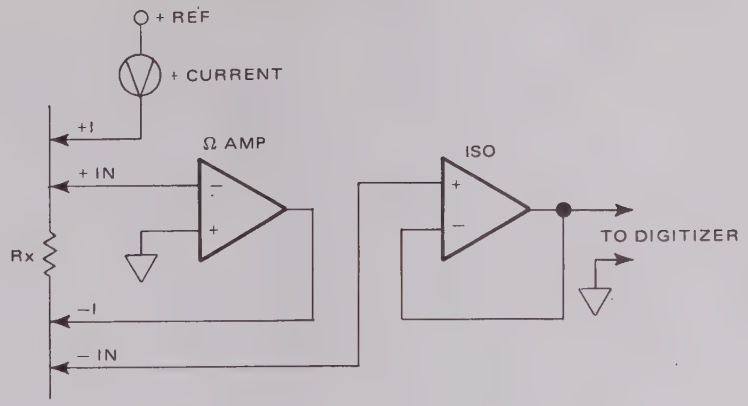
Figure 4.4 - Signal Flow of Switching Board



RANGE	K1	K2	K3	K4	K5	K6
r.01		■	■	■		
r.1	■	■	■			
r1	■	■				
r10		■				
r100				■		
r1K					■	
r10K						■

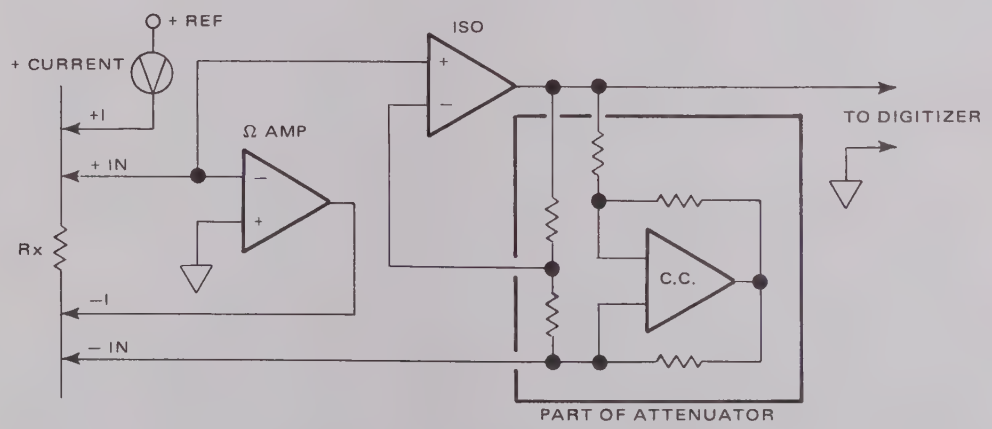
■ RELAY ENERGIZED

Figure 4.5 - Ohms Converter



RANGE	CURRENT	FULL SCALE OUT
10 KΩ	1 mA	–10V
100 KΩ	100 μA	
1000 KΩ	10 μA	
10 MΩ	1 μA	
100 MΩ	100 nA	

(a)



RANGE	CURRENT	GAIN	F.S. OUT
10Ω	10.1 mA	99	+10V
0.1 KΩ	11.1111 mA	9	+10V
1 KΩ	1.11111 mA	9	+10V

(b)

Figure 4.6 - Ohms Measurement Systems

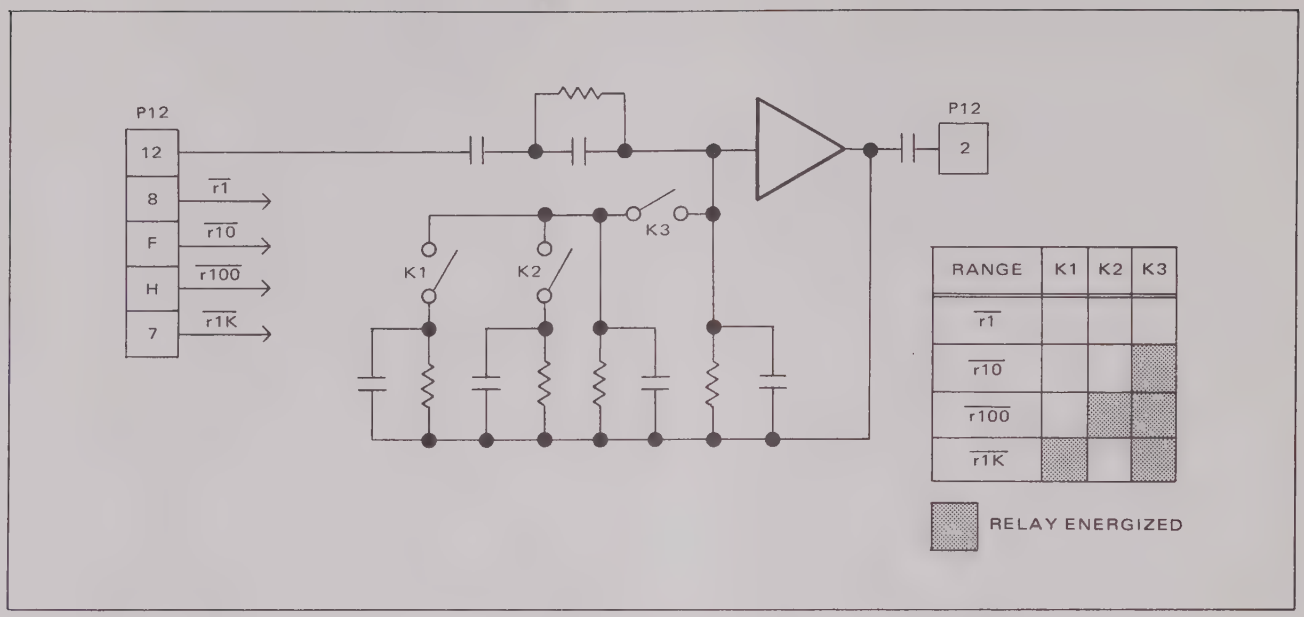


Figure 4.7 - Scaling Amplifier

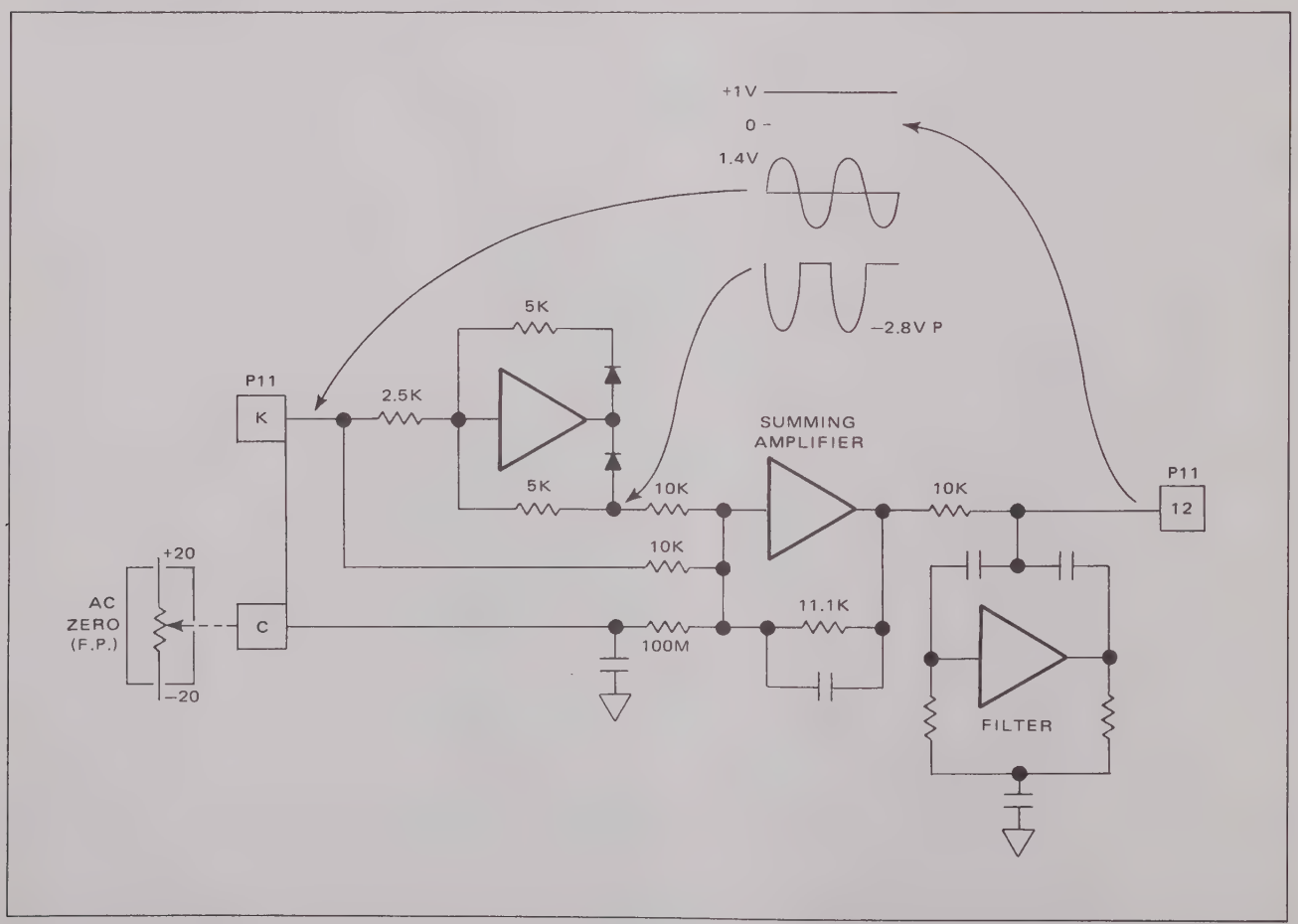


Figure 4.8 - Averaging AC Converter

4.21 Averaging AC Converter.

4.22 The Averaging AC Converter receives the scaled input from the Scaling Amplifier and generates a positive dc equivalent for the DVM measurement section. The circuitry is mounted on a single printed circuit board and occupies location J11 on the Main Logic board. The circuitry, shown simplified in figure 4.8, consists of an active rectifier, a summing amplifier, and an active filter circuit.

4.23 Referring to figure 4.8, a full scale input (1.414 volts peak) is shown applied to the input of the active rectifier. The active rectifier consists of an operational amplifier having two polarity selective feedback loops (one positive, one negative), and the closed loop gain of the circuits is set at 2. The output of the negative going feedback loop is fed through a resistor to the summing node of the summing amplifier. Also fed to this summing node and through a resistor is the full wave input signal. The summing amplifier adds the two inputs, averages them and multiplies the signal by 1.11 to produce the dc equivalent of the RMS input, or 1 volt dc. The ripple content is attenuated by the summing amplifier. A full scale input of 100 Hz would result in a ripple at the summing amplifier output of ≈50 millivolts. Further ripple attenuation is provided by the active 3-pole filter. For the same example, the filter would increase the ripple attenuation to ≈5 millivolts.

4.24 RMS AC Converter.

4.25 The circuitry is shown simplified in figure 4.9. The Scaling Amplifier consists of an operational amplifier with a fixed input impedance and four feedback paths. The feedback path for the one volt range is permanently wired into the circuit; the 10, 100, and 1000 volt range feedback paths are connected in parallel to the 1 volt feedback path by relays K1, K2, and K3. The scaling amplifier supplies an accurate 1 volt output on each range selected with full range inputs applied.

4.26 The active rectifier is an operational amplifier with two polarity selective feedback paths (one conducting only with a positive amplifier output and the other conducting only with a negative amplifier output). The voltage developed across the positive conducting leg is applied through a 10K resistor to the summing node of the log amplifier along with the full wave signal through a 20K resistor from the output of the scaling amplifier. These two inputs are combined and, due to the non-linear feedback loop of the log amplifier (consisting of Q14A and Q15A) produce the log of the combined signal at (c). This signal is fed through an identical path (consisting of transistors Q15B and Q14B) to the input of the summing amplifier.

4.27 The summing amplifier converts the signal to a dc level. The ripple content of the dc level is attenuated and the output reduced to provide a dc equivalent of the RMS value of the ac input signal.

4.28 Attenuator.

4.29 The Attenuator board is a single printed circuit board and occupies connector J7 on the Main Logic board. The Attenuator consists of a relay controlled voltage divider used on dc function that provides selectable scaling factors of X1, X.1, and X.01; a relay controlled feedback network used in conjunction with the isolator that provides selectable gain factors of X1, X10, and X100; and current compensation circuitry used in conjunction with the ohms converter.

4.30 Isolator.

4.31 The Isolator is a single printed circuit board and occupies connector J8 on the Main Logic board. The Isolator consists of a high open-loop-gain amplifier, a bootstrap amplifier, and a 3-pole filter. The amplifier is used potentiometrically and operates in conjunction with the attenuator board as shown in figure 4.10.

4.32 The bootstrap amplifier generates the + and – supply voltages for the input stages of the isolator, causing them to track the input signal. This results in an effective input impedance of greater than 10,000 megohms. The filter is an active 3-pole Bessel type connected by relay K1 to a point between the gain stage and the post amplifier of the isolator. The filter increases normal mode noise rejection from 10 to 48 dB (at 59 Hz) when K1 is energized. Filter selection is through the front panel switch or the remote programming option.

4.33 Switching Bypass.

4.34 The Switching Bypass board is a printed circuit jumper board and occupies connector J5. The Bypass board replaces the Switching board when the Ohms and AC converter options are not used in the DVM. The signals are routed through the Bypass board in exactly the same manner as in the Switching board when the dc function is selected. A block diagram of the Signal Conditioning section with the Bypass board installed is shown in figure 4.11.

4.35 INTEGRATION.

4.36 The Model 5900 uses an improved version of the standard dual slope integration method of analog-to-digital conversion, called delayed dual slope. As in the standard technique, the input signal is integrated for a set time

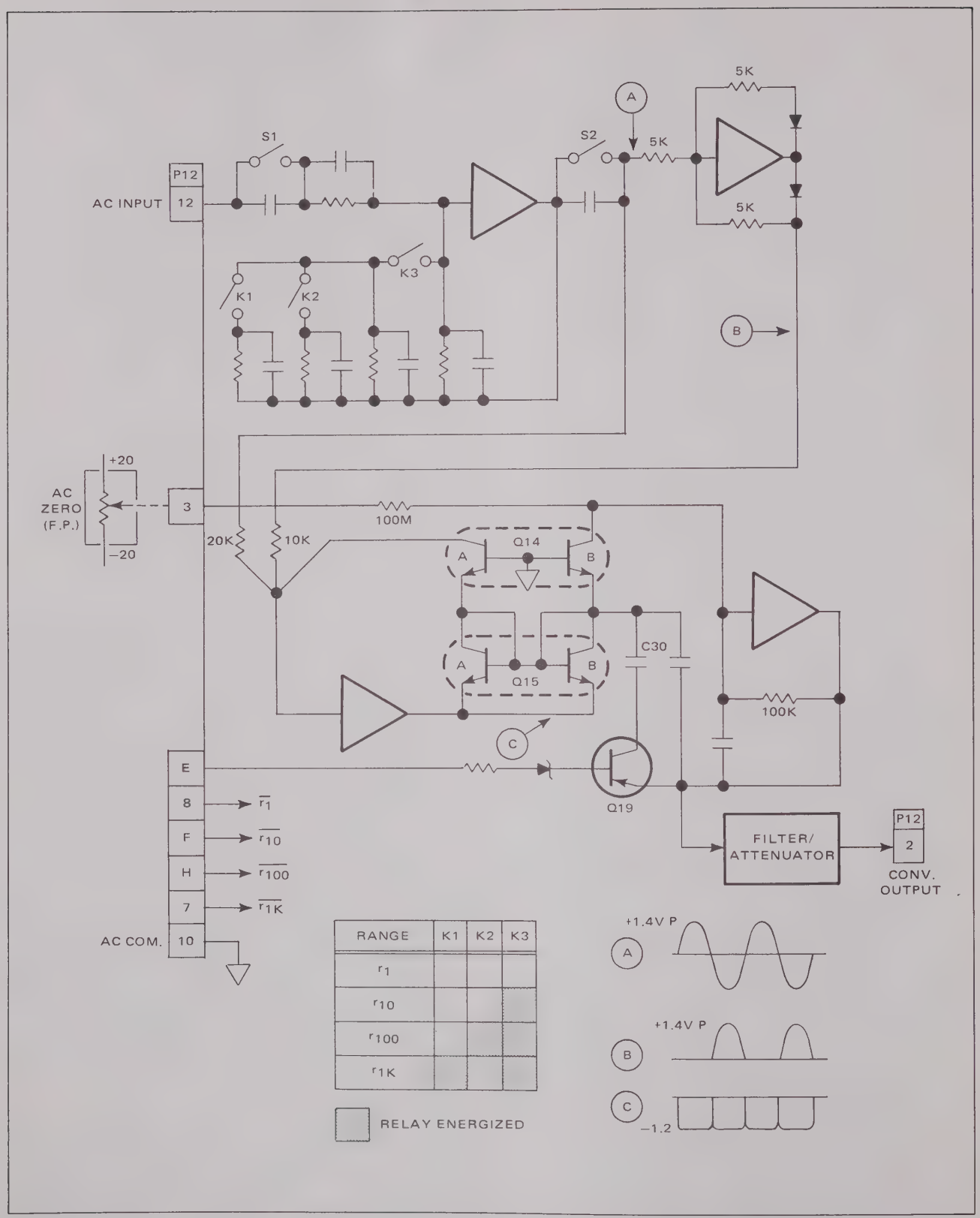


Figure 4.9 - RMS AC Converter

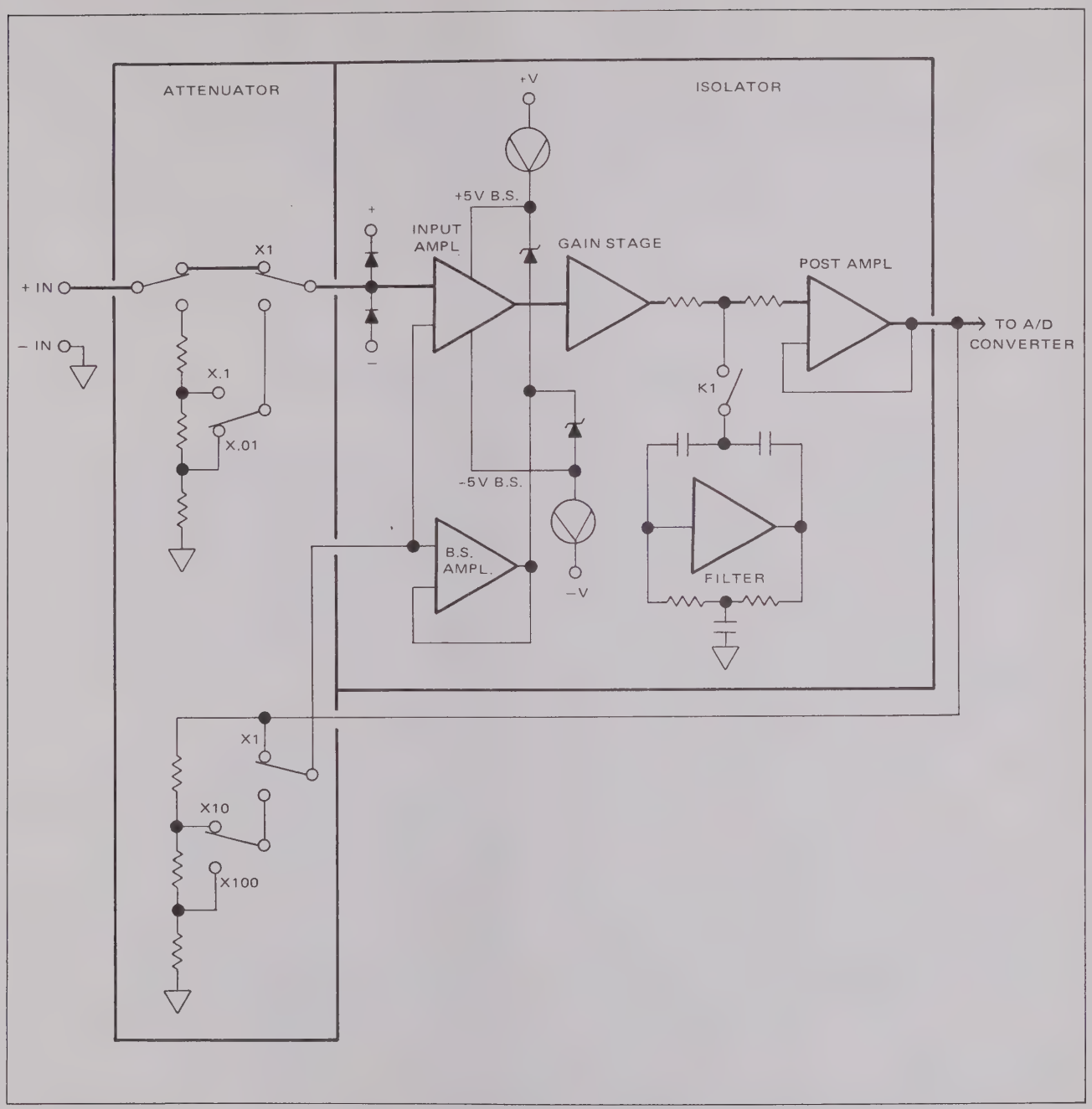


Figure 4.10 - Attenuator/Isolator DC

period to produce a voltage that is directly proportional to the input signal. At the conclusion of this signal integration period, the input signal is removed from the integrator and replaced by a fixed reference voltage whose polarity is opposite that of the input signal. This causes the integrate output voltage to discharge at a linear and fixed rate for a time period that is directly proportional to the voltage developed during the signal integration period. This reference integration time period is measured and displayed in the instrument readout. The transition from signal to reference integration in the A to D sequence, is accompanied by switch noise in the form of spikes. Due to this and normal mode noise which may accompany the input signal, the standard dual slope technique is subject to noise induced errors with input signals at or near zero. The delayed dual slope technique used in the Model 5900 DVM minimizes this source of measurement error by generating a period of non-measurement or delay between the two integration

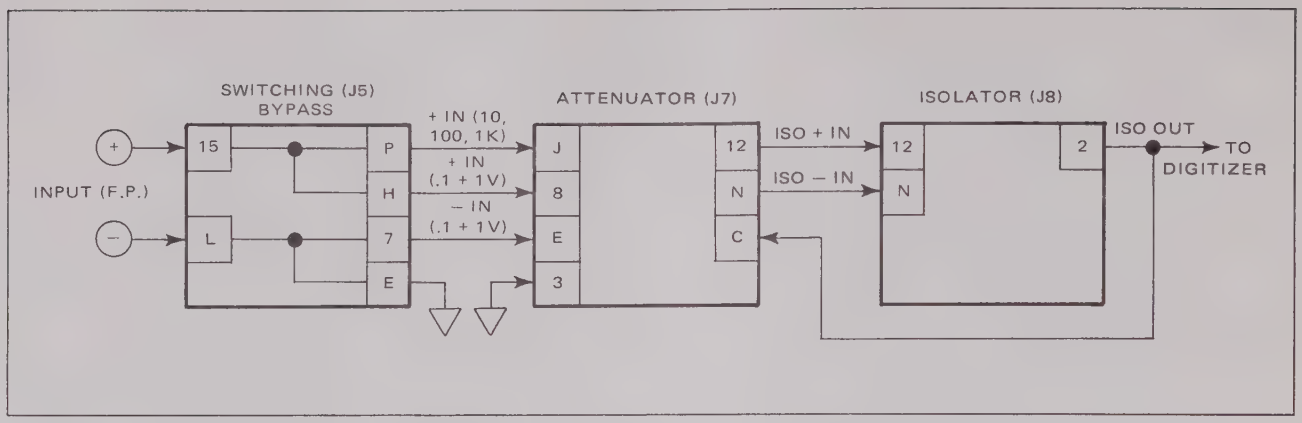


Figure 4.11 - Signal Flow, Switching Bypass

periods. The circuitry used to perform this task include both the Digitizer and portions of the Display/Logic section. In the Digitizer, shown in simplified form in figure 4.12, this is reflected as an adjustment to the basic shape of the integrator output signal as shown in figure 4.13. The 'delay' portion of the integration cycle is initiated immediately following the signal integrate period and is the result of two factors. First, an analog level equal to 180 digits and of a polarity that resists the axis crossing from occurring, is produced at the integrator output by a network called the feed forward circuitry. Second, a capacitor in the feedback network of the gain stage that follows the integrator adds to the total delay period. The total effect is a fixed delay of the axis crossing signal of 200 digits.

4.37 Digitizer.

4.38 The circuitry that performs the A/D conversion is mounted on the single, printed circuit Digitizer board and occupies connector J9 on the Main Logic board. The circuitry includes: an integrator and switching network, a gain stage, null detector, transformer driver, signal and reset logic, switch controls and + and − reference supplies.

4.39 INTEGRATOR.

4.40 The Integrator consists of an operational amplifier with a capacitive feedback path to convert the dc levels applied to its input to a corresponding ramp voltage at the integrator output. The use of a dual FET input stage provides a correspondingly high input impedance and permitting capacitor input coupling during the integration period and allowing auto-zeroing during reset. The feed forward circuitry is a voltage divider network that takes a portion of the reference voltage and applying it to the non-inverting input of the integrator. This results in an equal amount of voltage appearing at the integrator output.

4.41 The integrator switches consist of junction FET's, controlled by circuitry located on the Digitizer. Referring to figure 4.12, switch S1 conducts during the signal integration period, switch S2 or S3 during reference integration and S4 and S5 during reset. The output of the integrator is coupled to the following Gain Stage through two FET's connected as current generators. The purpose of these generators is to prevent loading of the Isolator while maintaining reasonable coupling to the gain stage input.

4.42 GAIN STAGE.

4.43 The gain stage greatly increases the amplitude of the integrator output especially in the area near zero to provide a more clearly defined axis crossing signal for the null detector to respond to. The gain stage also exhibits low pass filter characteristics which, as previously discussed, adds to the total delay of the integration sequence. This reduces the total noise response of the system and reduces the wide band response requirements of the null detector. The circuit consists of a potentiometric amplifier with a programmed gain control, providing gains of 300 for stage inputs of up to 13 mV and decreasing to 14 for signals above this level.

4.44 NULL DETECTOR.

4.45 The Null Detector consists of an inverting, open-loop amplifier with an output swing of 5 volts. The Null Detector converts the amplified analog signal (ramp) from the integrator to a digital level (logic 1 ≍ +5 volts and logic 0 ≍ 0 volts). This digital signal, called either the null detector output or axis signal is used on the Digitizer board for determining the polarity of the reference to be used for the reference integration and, by way of the transformer driver and transformer T1, the circuitry of the Display/Logic section of the main assembly.

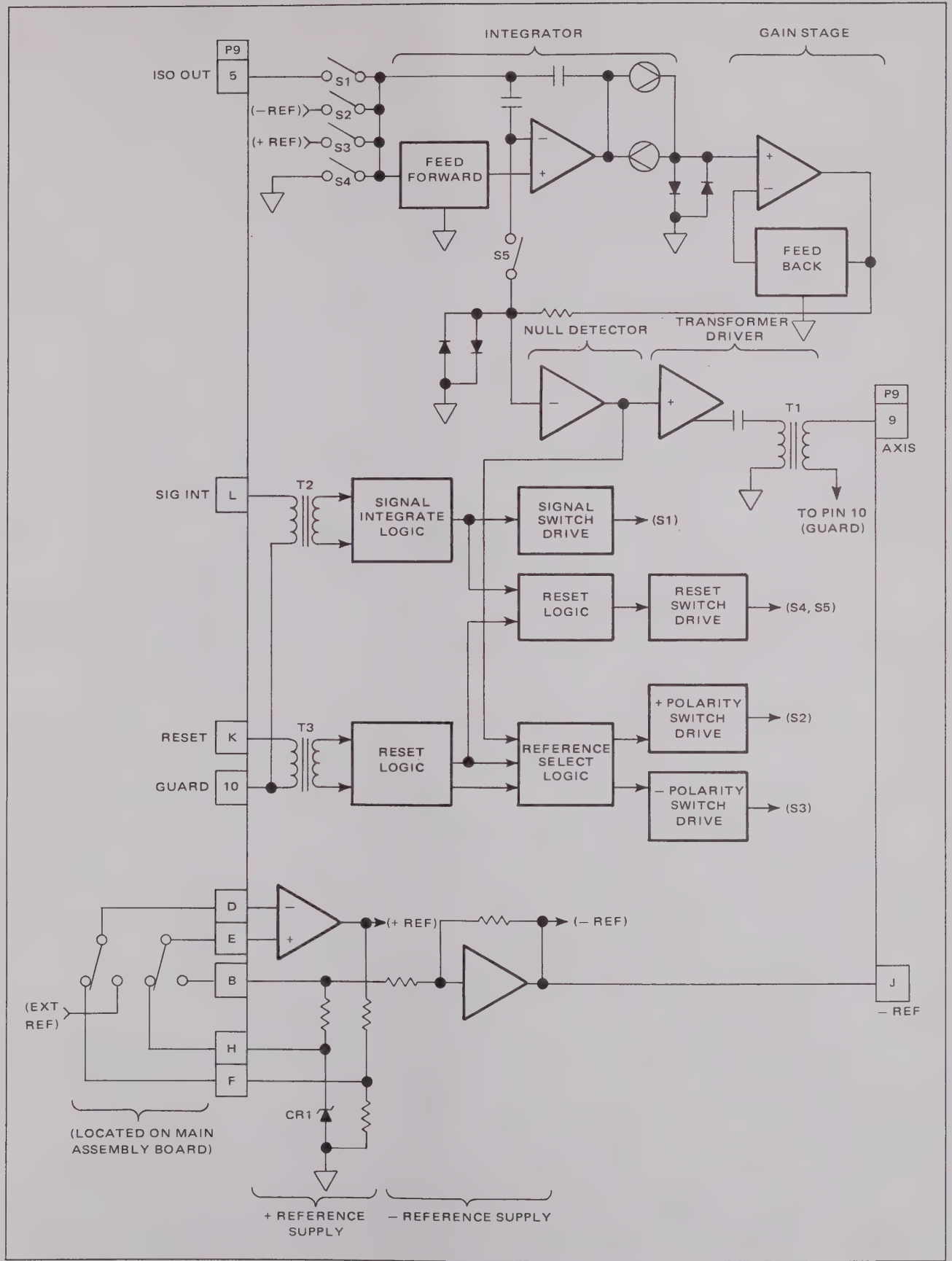


Figure 4.12 - Digitizer

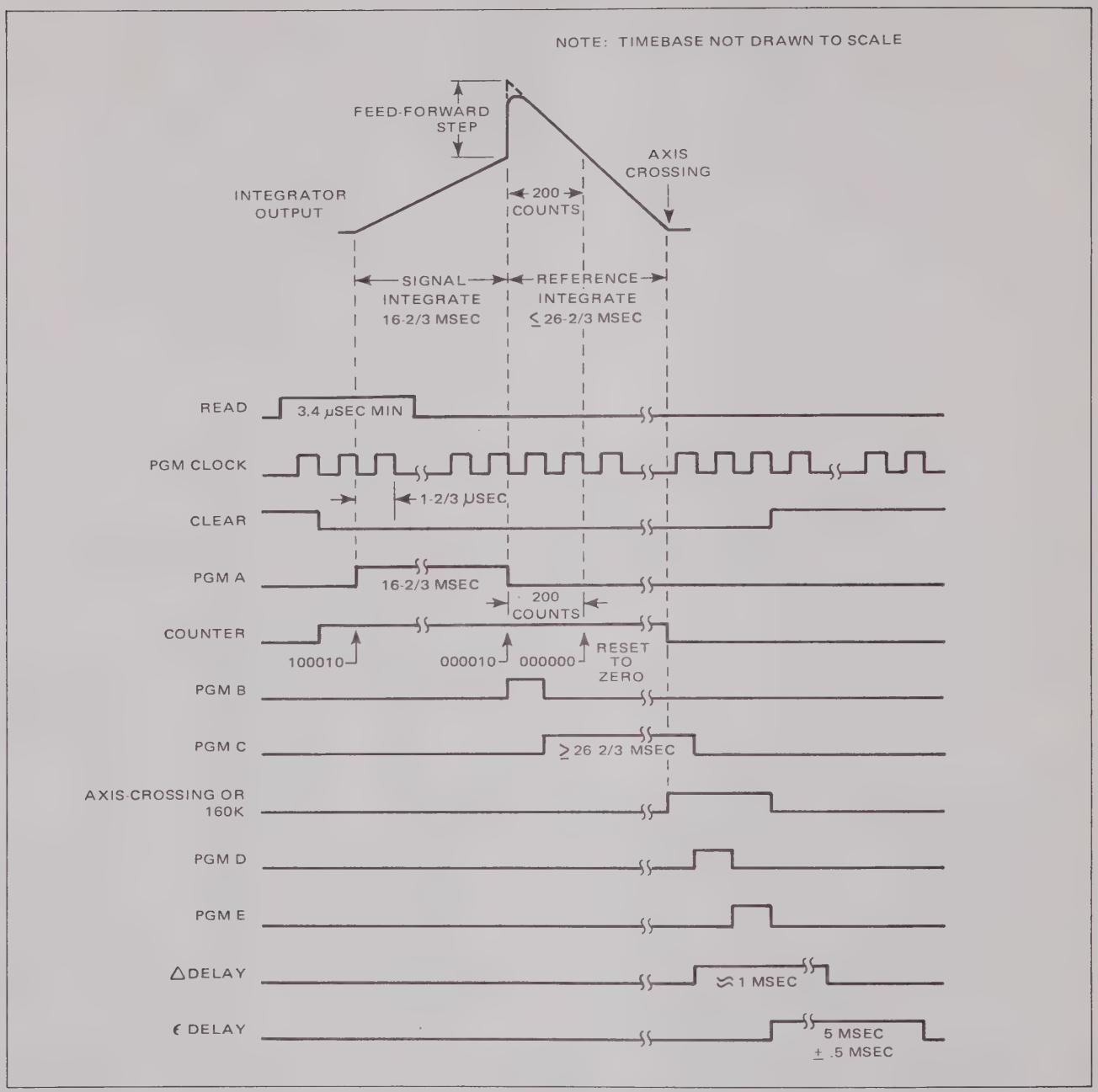


Figure 4.13 - Integration Timing Diagram

4.46 TRANSFORMER DRIVER.

4.47 This circuit consists of a complementary emitter-follower, capacitor coupled to the isolation transformer T1.

4.48 SIGNAL AND RESET LOGIC.

4.49 This circuitry operates from pulse data obtained through isolation transformers T2, T3 and originating from control circuitry of the Display/Logic section. The data is converted into control signals for operating the integration switches.

4.50 DIGITIZER LOGIC.

4.51 The Digitizer Logic receives its timing information through isolating data transformers T2 and T3. The logic converts this information into control signals that operate the FET switches. The timing of the input data and switch operation is provided in figure 4.13.

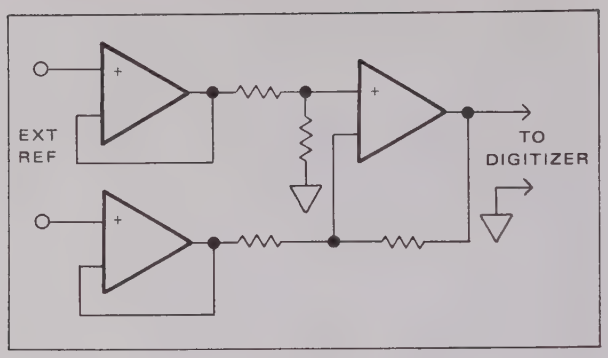


Figure 4.14 - 4-Wire Ratio Option

4.52 Ratio Option.

4.53 The four wire ratio circuitry is mounted on a single printed circuit board and occupies connector J14 on the Main Logic board. The 4-wire ratio option eliminates ground loop errors in ratio measurements by permitting the reference input common lead to float in reference to the signal input common. The circuitry, shown in figure 4.14, consists of two gain-of-one isolation amplifiers driving a differential potentiometric amplifier. Field installation of the ratio board requires removal of jumpers W1 and W2 on the Main Logic board.

4.54 Display Board.

4.55 The Display board is a single printed circuit board and occupies connectors J1 and J2 on the Main Logic board. The display board is located directly behind and parallel to the front panel of the instrument; the function and range control knobs on the front panel are connected by shafts to the rotary switches on the display board. A mechanical interlock attached between the two shafts prevents the manual selection of incorrect function/range combinations. The display board contains the function, the manual and autorange, and the annunciator circuitry. The circuit is shown in simplified block form in figure 4.15 and described below.

4.56 FUNCTION AND RANGE SWITCHES.

4.57 These generate a negative true output and operate only in local control (programming not selected). The function switch has three positions generating outputs (from left to right) of $\overline{AC}$, $\overline{DC}$, and $\overline{\Omega}$. The range switch has nine positions and generates the outputs shown in table 4.2.

4.58 DATA ENCODE.

4.59 The output of the range switch is converted to positive true 1248 BCD logic by this circuitry. The BCD

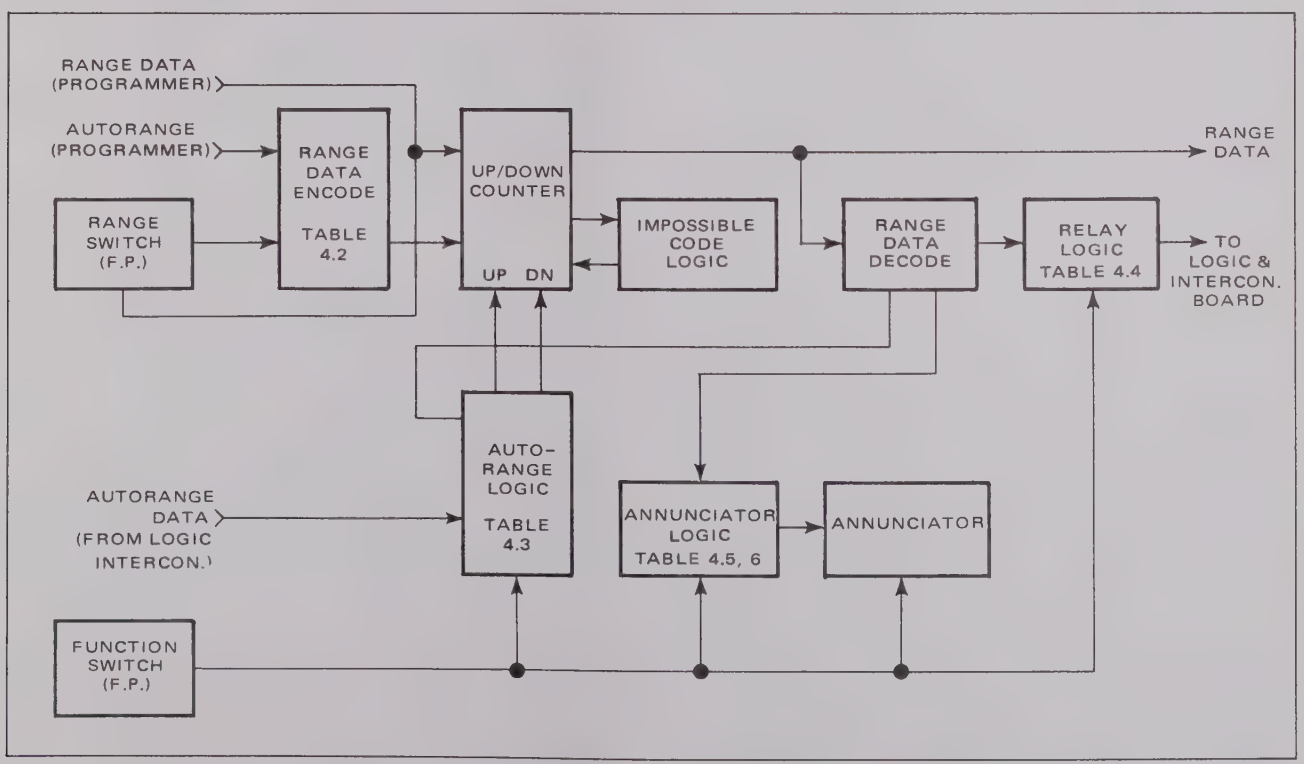


Figure 4.15 - Display Board

Table 4.2 - Range Switch Code

RANGE SWITCH	SWITCH OUTPUT	DATA ENCODE OUTPUT				BINARY WEIGHT
		A	B	C	D	
10 Ω	$\overline{R2}$	F	T	F	F	2
.1	$\overline{R3}$	T	T	F	F	3
1	$\overline{R4}$	F	F	T	F	4
10	$\overline{R5}$	T	F	T	F	5
100	$\overline{R6}$	F	T	T	F	6
1000	$\overline{R7}$	T	T	T	F	7
AUTO	--	F	F	F	F	0
10M	$\overline{R8}$	F	F	F	T	8
100M	$\overline{R9}$	T	F	F	T	9

output is the same as produced by the programmer for remote range selection and is shown in table 4.2. The four BCD output lines from the data encode are applied to the up/down counter.

4.60 UP/DOWN COUNTER.

4.61 The up/down counter is a decade counter capable of counting up from 0 to 9 and overflowing to 0, counting down from 9 to 0 and overflowing to 9, being preset to the BCD input, and being cleared to zero. In manual range the up/down counter is held in the preset mode and the output of the counter always equals the BCD code from the data encode circuitry. In autorange the BCD input from the range data encode is inhibited and the output of the counter is controlled by the autorange logic.

4.62 AUTORANGE LOGIC.

4.63 The autorange logic generates the control pulses for advancing the counter up or down. Data are received from the function switch and from the range data decode circuit, a BCD to 10-line converter. If no range change is required the circuitry generates no control signals and the counter is not advanced. An up range signal is generated during the Program D period if an up range 160% signal is true and the $\overline{\text{up range}}$ inhibit signal is not false (see table 4.3). One up range signal is generated per measurement cycle. A down range signal is generated during the Program D period if the down range 15% signal is true and the $\overline{\text{down range}}$ inhibit signal is not false (see table 4.3). One down range signal of this type is generated for each measurement cycle. In the event that the counter is in a forbidden range (not available for the function selected), during the clear period, the counter is made to down range

Table 4.3 - Autorange Logic

DATA	INHIBIT					FORBIDDEN RANGE					
	$\overline{\text{UP RANGE}}$		$\overline{\text{DOWN RANGE}}$								
$\overline{DC}$			F								
$\overline{AC}$				F					F		
Ω	F					F					
$\overline{\Omega}$		F			F		T	T			
$\overline{R0}$										F	
$\overline{R1}$											F
$\overline{R2}$					F	F					
$\overline{R3}$			F						F		
$\overline{R4}$				F							
$\overline{R7}$	F										
$\overline{R8}$							F				
$\overline{R9}$		F						F			

at the clock rate until the counter is in an available range. The autorange circuitry then operates normally to select the most appropriate range. The forbidden ranges are indicated in table 4.3. If the counter output produces an 'impossible code' (as could happen when the instrument is turned on and autorange is selected), the impossible code logic resets the counter to zero; the autorange circuitry then selects the appropriate range.

Table 4.4 - Relay Logic Coding

RANGE	FUNCTION						
	Ω		DC			AC	
	.1 + 1	1 + 100	.1 + 1	1 + 100	100 + 1000	.1 + 1	1 + 100
10 Ω	■						
.1	■	■	■				
1	■			■		■	■
10						■	■
100					■	■	■
1000						■	■
10M							
100M							

■ ENERGIZED

Table 4.5 - Annunciator Logic

INPUT	ANNUNCIATOR											
	PGM	FILTER	RATIO	DC	AC	Ω	KΩ	MEG		NO	+	–
$\overline{\text{SYSTEM CONTROL}}$	F											
$\overline{\text{FILTER}}$		F										
$\overline{\text{RATIO}}$			F									
$\overline{\text{DC}}$				F							F	F
$\overline{\text{AC}}$					F							
$\overline{\Omega}$						F	F	F	F			
W1 (JUMPER)						IN	IN	IN	IN	SEE TABLE 4.6		
W2 (JUMPER)					IN							
$\overline{\text{R2}}$						F						
$\overline{\text{R8}}$							T	F				
$\overline{\text{R9}}$							T		F			
+ POLARITY											T	
– POLARITY												T

4.64 RELAY LOGIC.

4.65 The relay logic is generated by data from the range data decode and the function switch and is used via optically coupled isolators on the Main Logic board to control the attenuator range relays. The codes as shown in table 4.4 indicate the attenuator relay closure.

4.66 ANNUNCIATOR LOGIC.

4.67 The annunciator logic controls the selection of the annunciator lamps as shown in tables 4.5 and 4.6.

4.68 MAIN LOGIC AND CONTROL CIRCUITRY.

4.69 This circuitry, shown in the block diagram of figure 4.16, is located on the Main Logic board and consists of the control and display logic. In general this circuitry controls all instrument operation including the integration cycle, 'times' the output of the digitizer, and converts this information into data compatible with the Display board.

4.70 Control Logic.

4.71 This circuitry controls the operation of the instrument and consists of the program logic, program counter,

Table 4.6 - "NO" Annunciator Logic

INPUT	NO									
UP RANGE 160%	T									
CLEAR		T	T	T	T	T	T			
$\overline{\text{R0}}$		F								
$\overline{\text{R1}}$			F							
$\overline{\text{R2}}$						F				
$\overline{\text{R3}}$							F			
$\overline{\text{R7}}$				F						
$\overline{\text{R8}}$					F					
$\overline{\Omega}$				T	T	T			F	
$\overline{\text{AC}}$							F			F
PROGRAM								T		
$\overline{\text{SYSTEM CONTROL}}$								T		
W1 JUMPER									OUT	
W2 JUMPER										OUT

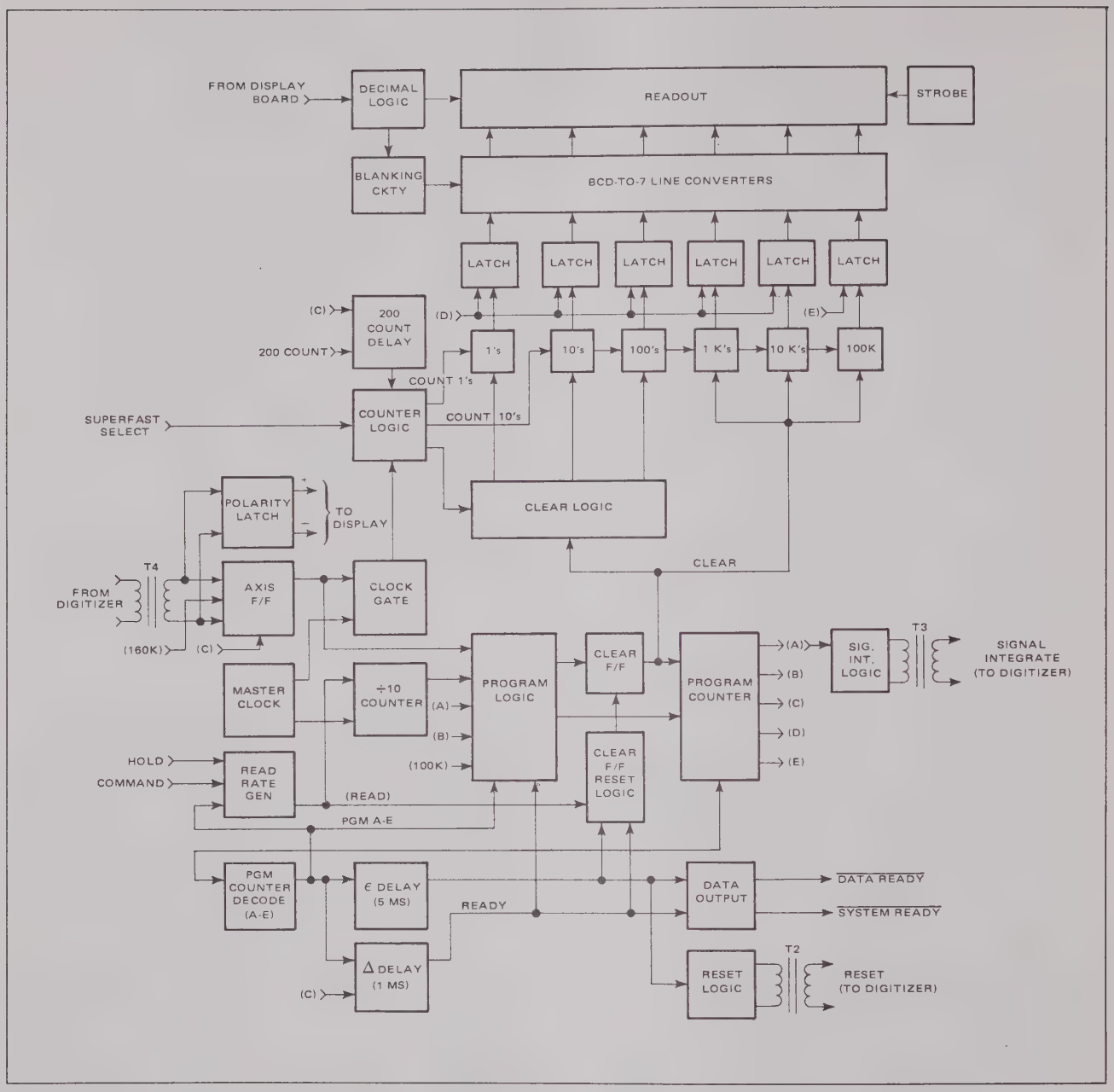


Figure 4.16 - Main Logic & Control Block Diagram

program clock, read rate generator, master clock, clear logic, and counter logic. The instrument operates on a five step program cycle produced by the program circuitry. This consists of a five stage shift register (or program counter), a program clock, and control logic. The five outputs of the program counter correspond to the five program states (PGM A, PGM B, PGM C, PGM D, and PGM E). Only one output of the counter is true at any time during the measurement cycle of the instrument and all of the outputs are false when the instrument is in clear. The program counter is advanced by a gated square wave from the program clock. The program clock output is driven by and equal to the master clock frequency divided by 10 or 600 kHz and is synchronized with the counter at the start of each measurement cycle. The correlation between the master and program clocks causes a 10 count lag between the program counters advancing during the signal integration period and the counter.

4.72 Program Cycle.

4.73 Preceding the start of the measurement cycle, the instrument is in a clear state with the counter set to 100000 and the logic in the reset state. Upon receipt of a read command, whether from the read rate generator or by an external command, the clear signal is removed and the counter begins counting. After ten clock counts (100010) the program counter advances to PGM A. Program A, via the pulse transformer T3, initiates the signal integrate period of the integration cycle on the digitizer board. Program A is terminated after the counter is advanced 100,000 counts. The period is a precise 16-2/3 millisecond and the counter now reads 000010 (the counter overflows to zero at 199,999). At the completion of Program A, Program B is initiated, lasting for 200 clock cycles. This period corresponds to and provides the required digital delay for the analog delay period between the signal and reference integrate periods of the digitizer as described in paragraph 4.36. At the completion of the 200 count delay (PGM B), the 1's, 10's, and 100's decades of the counter are reset, causing the counter to read 000000. At the same time the program counter is advanced to Program C, which in turn enables the axis crossing detector. The program counter remains in this state until (1) an axis crossing signal is received, indicating the reference integration period of the digitizer is completed or (2) the counter reaches 160,000, indicating an overload condition. One of these two inputs causes the axis flip-flop output to go true, inhibiting the clock gate and stopping the counter. The program counter is advanced to Program D and the Δ (delta) delay is initiated. The delta delay lasts for about 1 millisecond and prevents the ready line from going through until after the program counter has completed its cycle. Program D lasts for one program clock cycle and strobes all but the 100K latches. The program counter then advances to Program E which also lasts for one program clock cycle and strobes the 100K latch. At the end of Program E, the Program A-E line goes false, resetting the read rate oscillator, starting the ϵ (epsilon) delay which lasts for 5 milliseconds and generates the reset signal for the digitizer, and generates the clear signal which sets the counter to 100,000 and resets the logic. At the end of the delta delay, the ready line goes true generating the $\overline{\text{DATA READY}}$ output signal and enables the program logic to receive a new read command. At the completion of the epsilon delay, the $\overline{\text{SYSTEM READY}}$ signal is generated and indicates that the instrument is able to accept an external read command. This returns the circuitry to the state at the start of the program cycle.

4.74 Display Logic.

4.75 This circuitry consists of the counter, latches, BCD-to-7 line converters, display strobe, clear logic, decimal logic, and the counter control logic. The counter consists of five series connected decade counters and a J-K flip-flop, and is capable of counting from 000000 to 199999 and then overflowing to 000000. The counter is driven by the 6 MHz master clock by way of the clock gate and the counter logic. The clock gate permits the counter to advance only during the measurement cycle. The counter logic circuitry routes the clock signal for normal or superfast operation. The clear logic operates in conjunction with the clear flip-flop and the counter logic to clear all or portions of the counter depending on normal or superfast operation for different parts of the measurement cycle. The latches store the information from the counters from the last measurement cycle in the form of BCD data. The units through 10K latches are strobed (the information at the input of the latch is transferred to the latch output 1 at Program D; the 100K latch is strobed at Program E. The data from the latches are converted to be compatible with the seven segment LED displays by the BCD-to-7 line converter. The converters are also used in conjunction with the decimal logic to provide leading zero blanking. The LEDs on the readout board are controlled by the BCD-to-7 line converters and powered by the driver decoder strobing circuit. This consists of a one-shot driven by a 120 Hz signal. The strobe permits the LED's to operate at their greatest efficiency while maintaining low overall power consumption.

4.76 Superfast.

4.77 This is a high speed operating mode in which the instrument is effectively converted to a four decade instrument. The actual selection of this mode and timing considerations are covered under paragraphs 2.68 and 2.105. Basically the superfast mode is achieved by bypassing the least significant decade (1's) with the counter logic. At the start of a superfast measurement cycle, the 1's decade is in the clear mode and the 6 MHz clock is applied directly to the input of the 10's decade. The signal integration time of the digitizer is reduced from 16-2/3 milliseconds to 1.6-2/3 milliseconds. The 200 digit time period must remain the same as in the standard measurement operation so the instrument is converted back to standard operation during the 200 count delay. At its completion the operation reverts back to superfast and the reference integration period is measured at the same rate the signal integration period was generated.

4.78 Power Supplies.

4.79 There are two separate power supplies used in the Model 5900; one provides the voltage levels required for operating the analog portions of the instrument and the other provides the voltage levels for the digital/display, data output, and programming. The two supplies use a common transformer core and primary winding but the supplies themselves are completely isolated to maintain the common

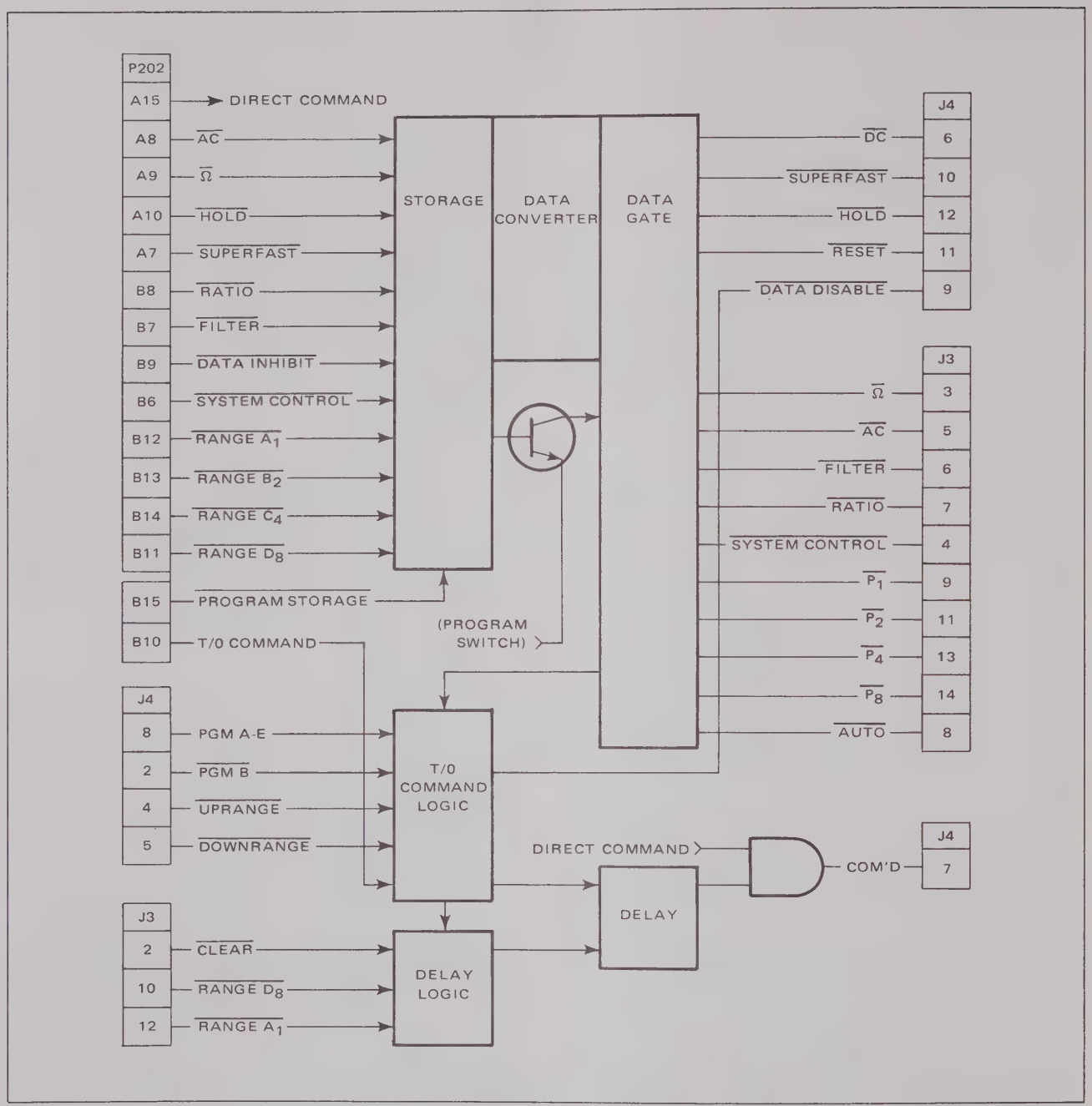


Figure 4.17 - Program Block Diagram

mode rejection characteristics of the instrument. The analog supply provide outputs of ±25 volts, ±20 volts, and –40 volts, all referenced to analog common (mecca). The digital supply provides outputs of +5 volts, +5 volts unregulated, and +150 volts, all referenced to digital common.

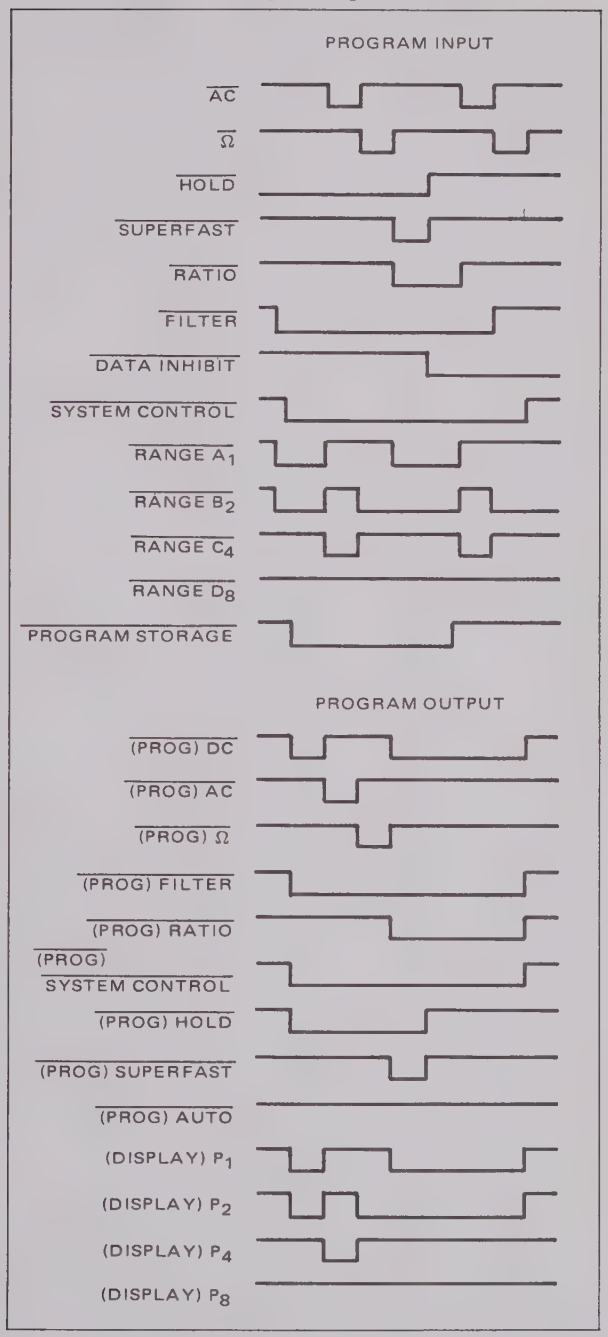
4.80 Program.

4.81 The program board is an option provided to allow external remote operation of the instrument. The circuitry is mounted on a single printed circuit board. The board is

located above and parallel to the Main Logic board and mounted to the Main Logic board on standoffs. Electrical connection between the Main Logic board and the Program board is by way of two cables (J3-J3A and J4-J4A). A portion of one end of the Program board extends through the rear panel of the instrument, through an opening provided for that purpose. This portion of the board forms an edge connector and is designated P202 PROGRAM INPUT.

4.82 The circuitry, shown simplified in figure 4.17, consists of the program logic, data gate, and the command/timeout circuitry. The program logic converts the control line data generated at P202 to correspond to the instrument control lines. The data gate passes or rejects the converted data; the gate is enabled when the program switch is operated and system control is selected on P202. A series of inputs with their outputs are shown in table 4.7. The timeout circuitry generates the necessary timeouts for delayed remote programming. The timeout periods are covered under paragraph 2.99.

Table 4.7 - Program Logic Conversion



5.1 GENERAL.

5.2 Calibration of the basic DC circuits and of the optional Ohms Converter can be accomplished through the shield covering the analog portion of the instrument. The shield is accessible by removal of the top cover of the instrument. A summary of the calibration procedure is inscribed on the shield.

5.3 EQUIPMENT REQUIRED.

5.4 Equipment required for calibration is listed in table 5.1. The equipment indicated is capable of maintaining the short term accuracy required for calibration. The equipment must be calibrated or the deviation of the output must be known prior to calibration if full accuracy is to be obtained.

Table 5.1 - Equipment Required

Name	Recommended Type
DC Voltage Standard	Fluke 332A (or equivalent)
AC Lab Power Source	HP745/746 (or equivalent)
Standard Resistors: 100 ohms, 1000 ohms, 10 kilohms, 100 kilohms, 1 megohm, 10 megohms, and 100 megohms	
Microvoltmeter	Fluke 845A (or equivalent)

5.5 DC CALIBRATION (Figure 5.1).

NOTE

In instruments equipped with the optional 4-Wire Ratio option, it is necessary to remove the 4-Wire Ratio circuit board and connect jumpers across W2 and W3 on interconnection board.

5.6 Isolator Zero.

a. Select DC function and .1 volt range. Short the ± input terminals; connect microvoltmeter to ANALOG OUTPUT terminals. Set DC OFFSET (front panel) to the center of its mechanical span.

b. Adjust R14 (.1V Zero) on Isolator for a microvoltmeter reading of less than 100 microvolts.

c. Replace the jumper across the ± INPUT terminals with a 1 Megohm resistor. Adjust R3 (100V ZERO) for a reading of less than 10 millivolts.

d. Replace the resistor with a jumper. Select 10V range. Adjust R7 (10V Zero) for a reading on the microvoltmeter of less than 20 microvolts.

e. Repeat the above steps until all ranges are zeroed within the indicated tolerance.

5.7 DC Voltage Zero and Gain.

a. Select DC function and 10V range. Apply an input of +00.0010V. Observe readout and reverse polarity of input (–00.0010V). Adjust R27 (±10 DIGIT BAL) for same readout for "+" or "–" inputs. Adjust R40 (±10 DIGIT SPAN) for ± 10 digits.

b. Apply inputs listed in following tables to the front panel input terminals and the rear panel ratio input terminals. Select mode as listed for each step and adjust indicated control for a readout of ±10.0000.

F/P Input	Ratio Input	Select Mode	Adjust (on Digitizer)
–1.00000V	+1.00000V	Ratio	R5 (–RATIO LIN)
+1.00000V	+1.00000V	Ratio	R64 (+RATIO LIN)
–10.0000V	+10.0000V	Ratio	R2 (–10V RATIO)
–10.0000V		DC	R4 (–10V)
+10.0000V		DC	R57 (+10V)

c. Repeat the above steps as required until all steps are calibrated.

d. Verify that the voltage at the ANALOG OUTPUT terminals (on rear panel) is the same as the voltage on the input terminals at various input levels (±10V, ±1V, etc.).

5.8 DC RANGE CALIBRATION.

5.9 Apply inputs listed in the following table. Select DC function and range as listed for each step. Adjust the indicated control for a readout equal to the input voltage.

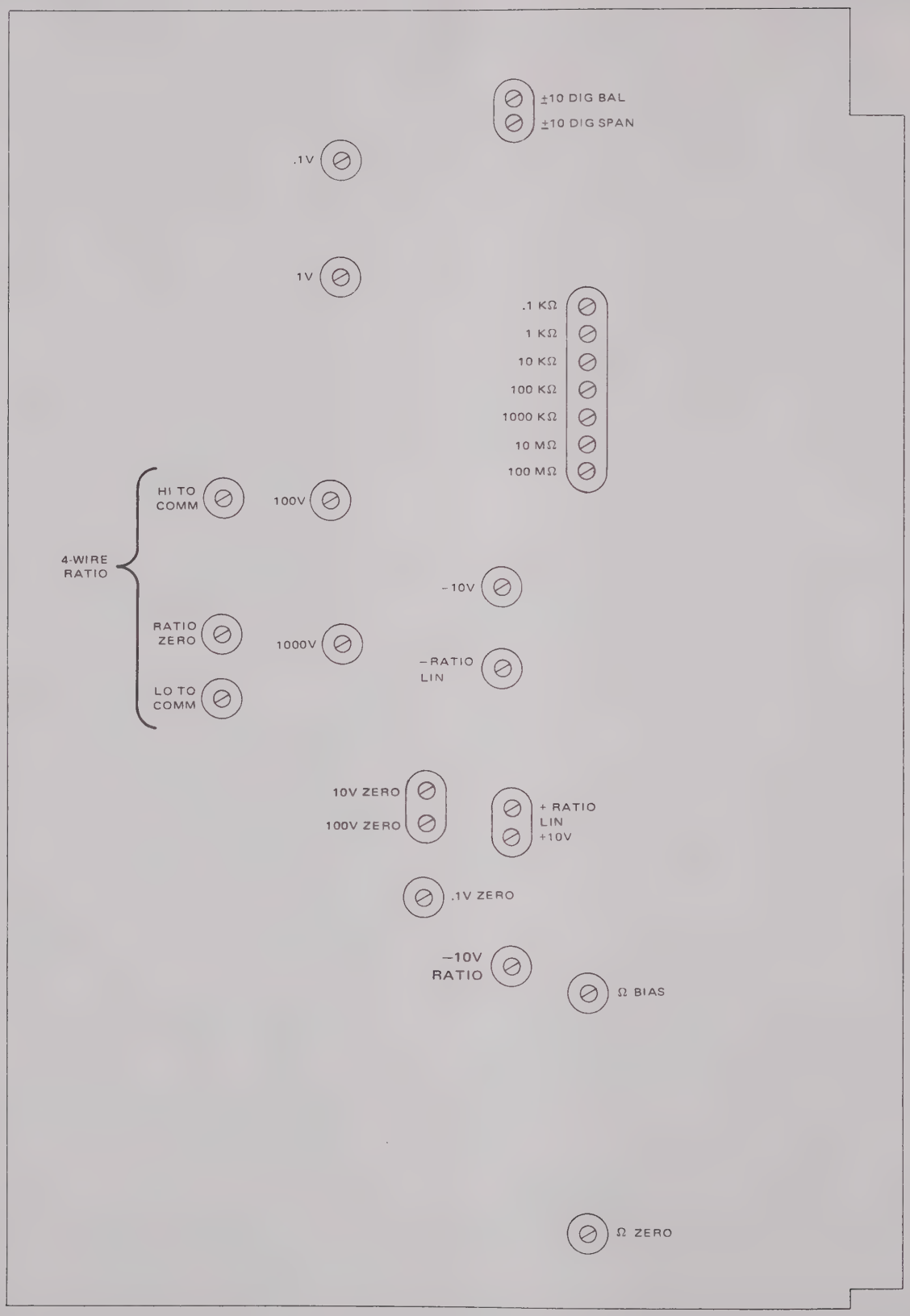


Figure 5.1 - Adjustment Locations

Input	Range	Adjust
+.100000V	.1	R18 (.1V)
–.100000V	.1	R18 (.1V)
+1.00000V	1	R5 (1V)
–1.00000V	1	R5 (1V)
+100.000	100	R11 (100V)
–100.000	100	Verify
+1000.00	1000	R13 (1000V)
–1000.00	1000	Verify

5.10 OHMS CALIBRATION (Figure 5.1).

5.11 Ohms Zero.

a. Select Ω-MΩ function and the 10 Megohm range. Short the ± INPUT and ± CURRENT terminals together. Adjust R56 (Ω ZERO) for zero readout.

b. Remove short from INPUT and CURRENT terminals. Connect a 10 Megohm standard resistor across the ± INPUT terminals. Do not connect the + CURRENT lead (figure 5.2).

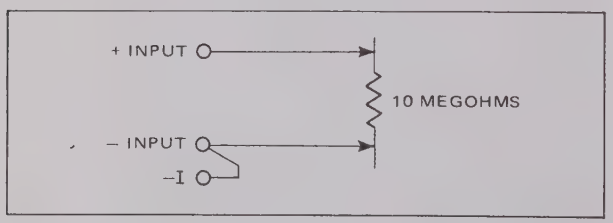


Figure 5.2 - Ohms Input Connection

c. Adjust R9 (Ω BIAS) for a readout of zero.

5.12 OHMS RANGE.

a. Connect standard resistors to the input in the order listed in the following table. Select range as listed for each step and adjust the indicated control for a readout equal to the standard resistor value. Connect as shown in figure 5.3.

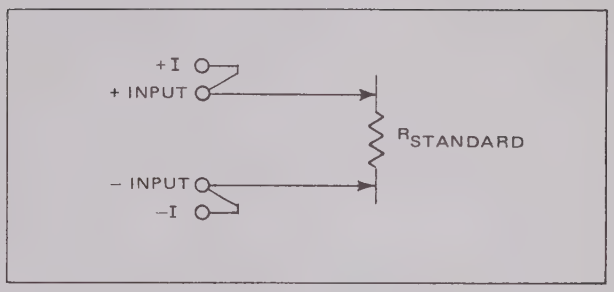


Figure 5.3 - Connections for Ohms Range Adjustment

Standard Resistor	Range	Adjust
100M	100M	R51 (100M)
10M	10M	R47 (10M)
1M	1000K	R45 (1000K)
100K	100K	R43 (100K)
10K	10K	R5 (10K)

b. Connect input with 4-wire configuration (figure 5.4) and complete the adjustments of the low ranges.

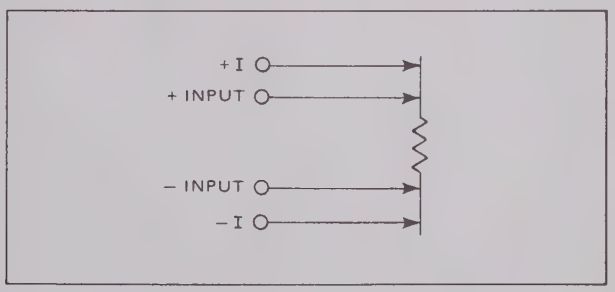


Figure 5.4 - 4-Wire Connections

Standard Resistor	Range	Adjust
1K	1K	R22 (1K)
100	.1K	R36 (.1K)
10	10	No adjustment; verify accuracy

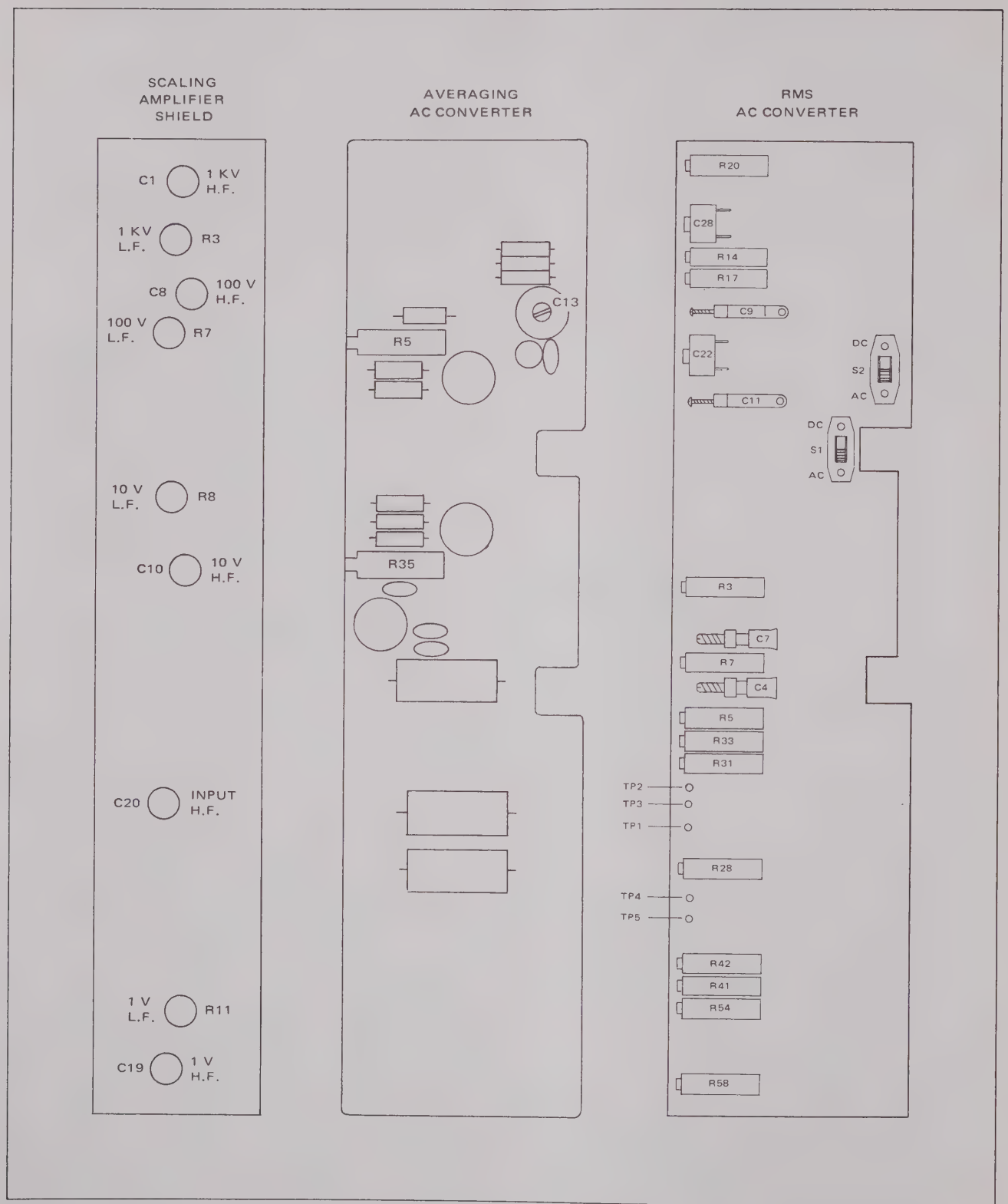


Figure 5.5 - AC Adjustment Locations

SECTION 6 DRAWINGS

Figure	Title	Page
6.1	Layout, Logic and Interconnection	6-3
6.2	Layout, Readout	6-3
6.3	Schematic, Logic and Interconnection	6-5
6.4	Schematic, Power Supply	6-7
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6.6	Schematic, Attenuator	6-9
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6.8	Schematic, Switching	6-11
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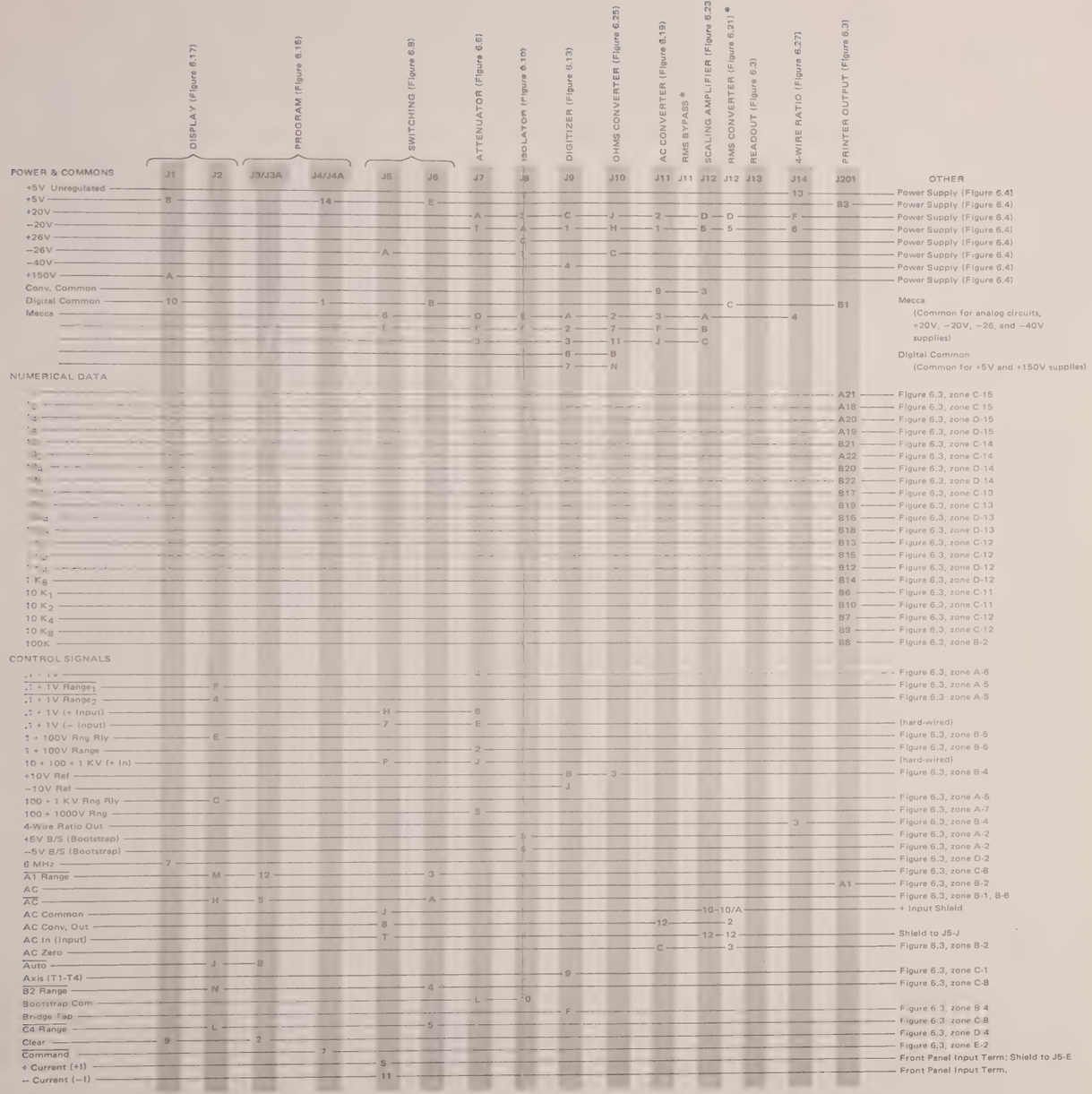
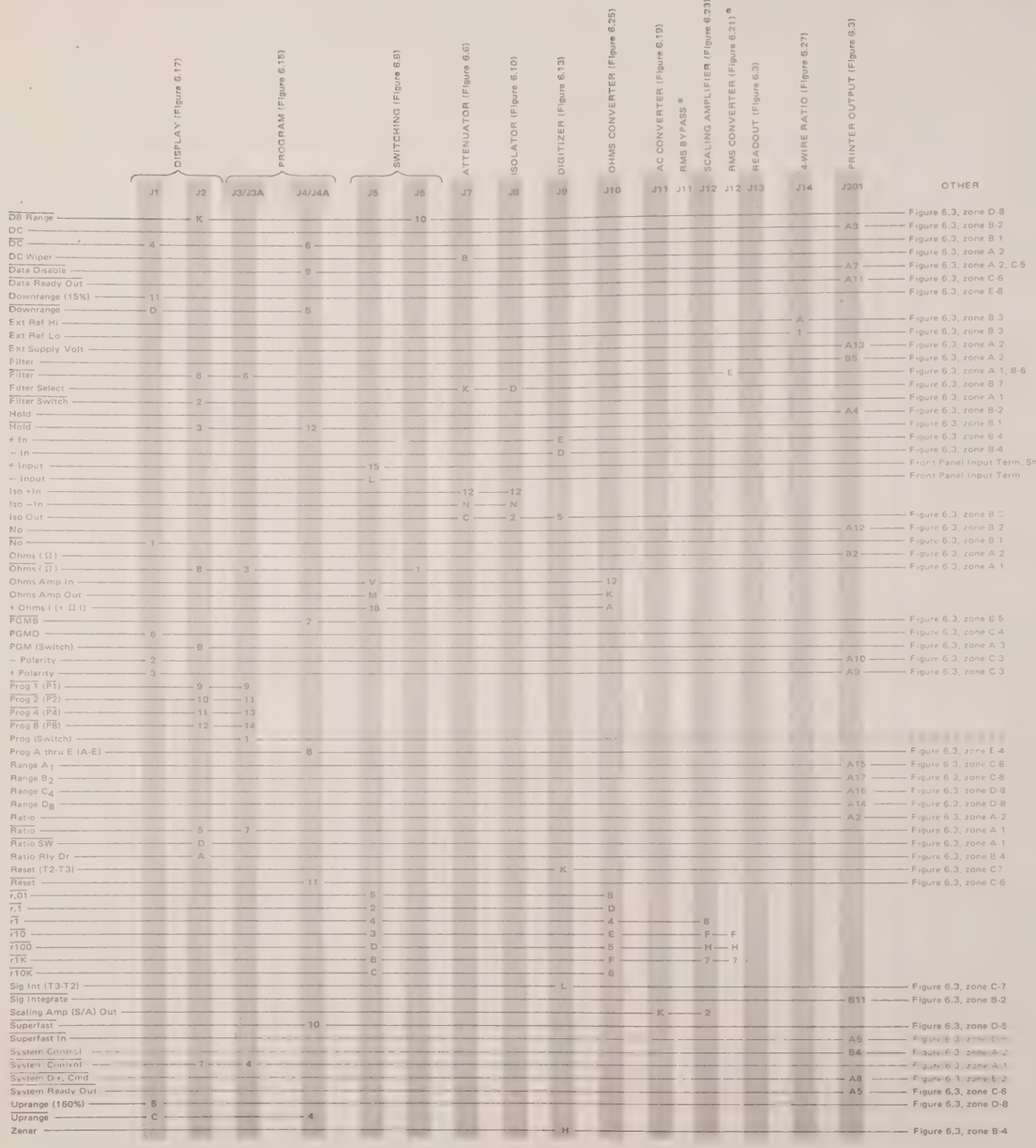
6.10	Schematic, Isolator	6-13
6.11	Layout, 10V Reference Amplifier	6-14
6.12	Layout, Digitizer	6-14
6.13	Schematic, Digitizer and 10V Reference Amplifier	6-15
6.14	Layout, Program	6-16
6.15	Schematic, Program	6-17
6.16	Layout, Display	6-18
6.17	Schematic, Display	6-19
6.18	Layout, AC Converter	6-20
6.19	Schematic, AC Converter	6-21
6.20	Layout, RMS Converter	6-22
6.21	Schematic, RMS Converter	6-23
6.22	Layout, Scaling Amplifier	6-24
6.23	Schematic, Scaling Amplifier	6-25
6.24	Layout, Ohms Converter	6-26
6.25	Schematic, Ohms Converter	6-27
6.26	Layout, 4-Wire Ratio	6-28
6.27	Schematic, 4-Wire Ratio	6-29

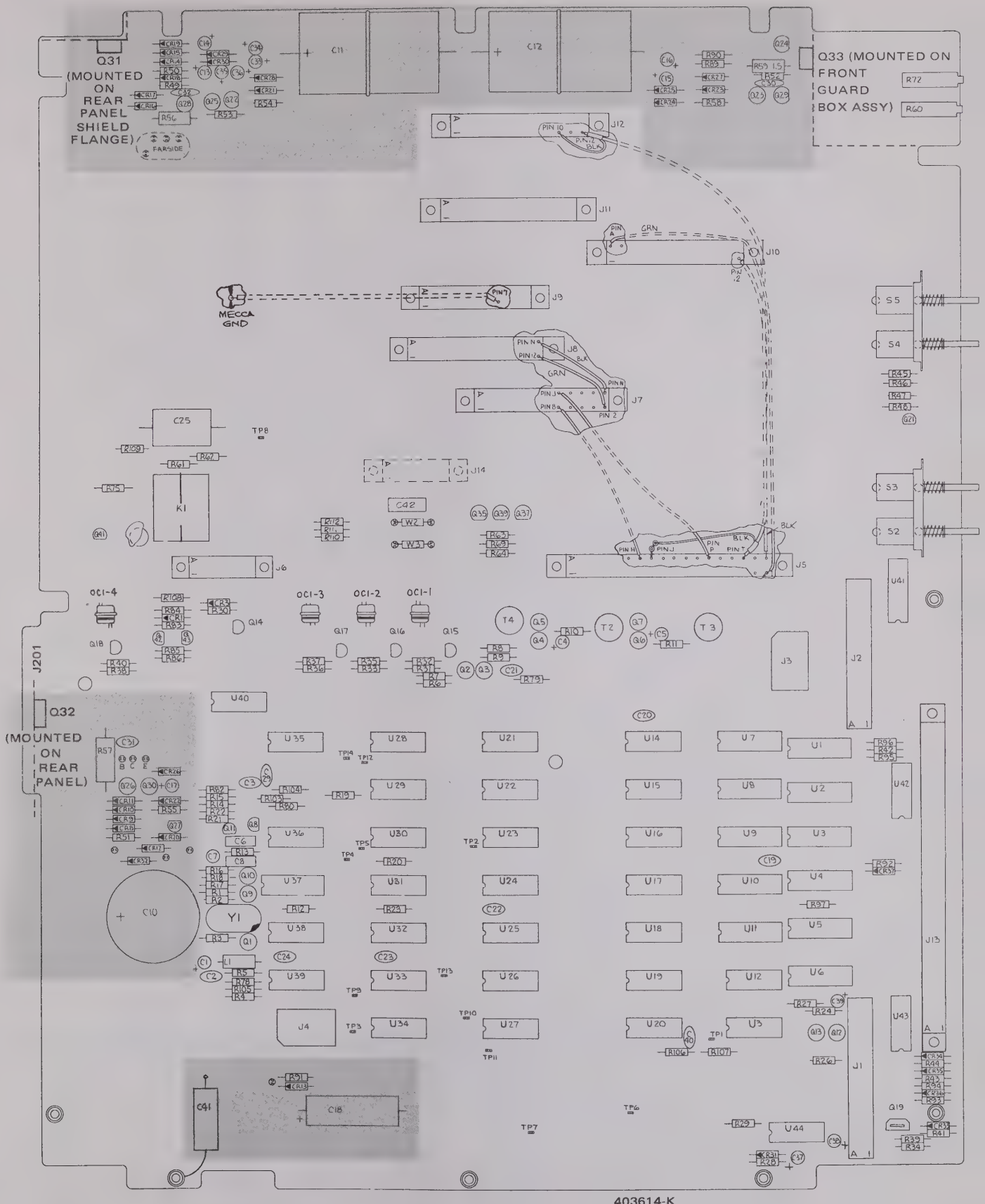
Table 6.1 - Signal Interconnection List

980453



* WHEN INSTRUMENT IS EQUIPPED WITH RMS CONVERTER (J12) THE RMS BYPASS BOARD (J11) IS ALSO USED



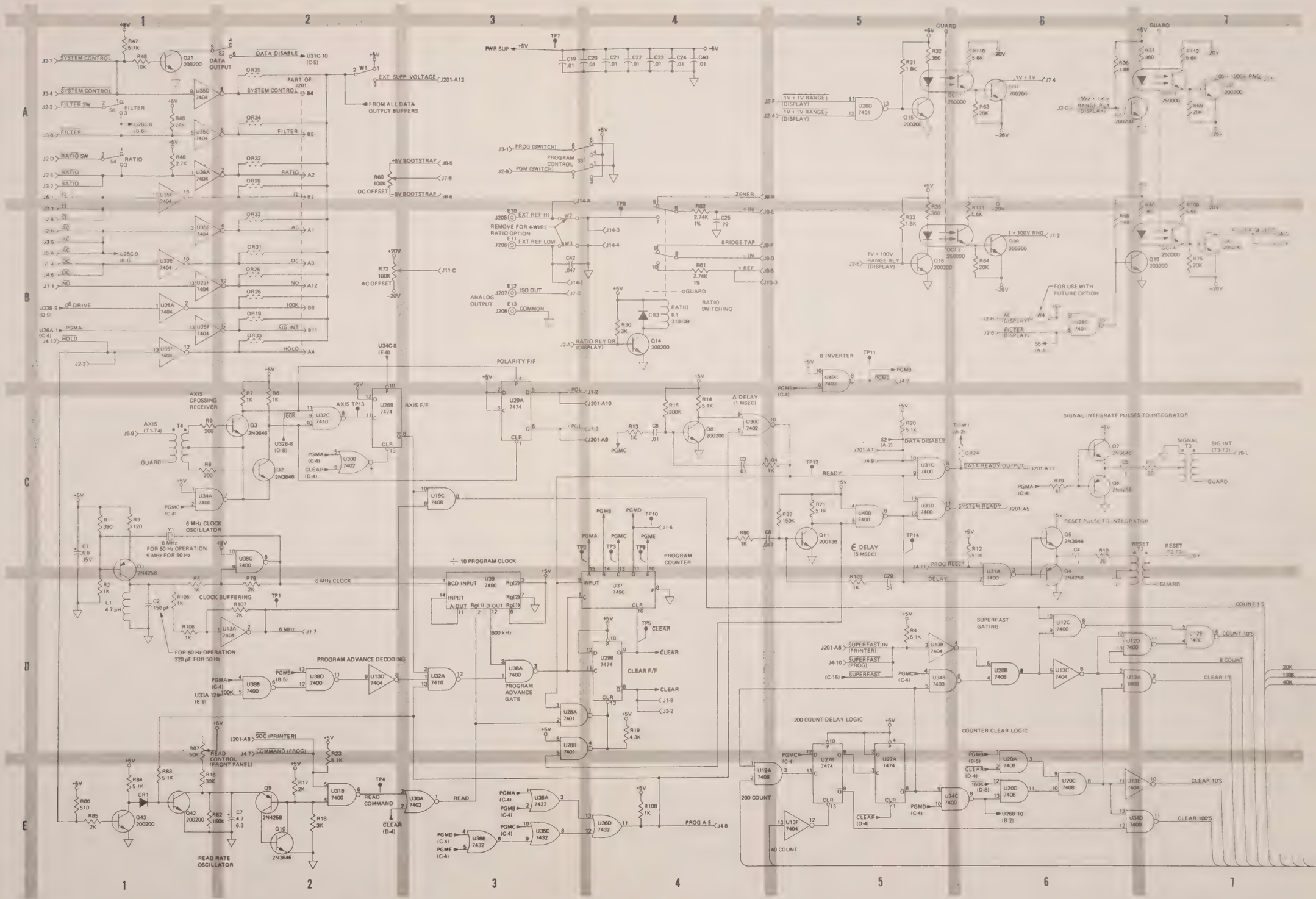


NOTES:

1. Reference designators shown as "U" on schematic and parts list may be identified on Logic and Interconnection Board as "M".
2. Power Supply Components Shaded.

Figure 6.1 - Layout, Logic and Interconnection

Figure 6.2 - Layout, Readout


SYSTEM CONTROL
FILTER SW
FILTER
RATIO SW
RATIO
DC DRIVE
PGMA
HOLD
DATA DISABLE
DATA OUTPUT
EXT SUPP VOLTAGE
FROM ALL DATA OUTPUT BUFFERS
+5V BOOTSTRAP
DC OFFSET
-5V BOOTSTRAP
AC OFFSET
PWR SUP
PROG (SWITCH)
PROGRAM CONTROL
PGM (SWITCH)
EXT REF HI
REMOVE FOR 4-WIRE RATIO OPTION
EXT REF LOW
ISO OUT
ANALOG OUTPUT
COMMON
ZENER
BRIDGE TAP
RATIO SWITCHING
RATIO RLY DR (DISPLAY)
GUARD
1V + 1V RANGE1 (DISPLAY)
1V + 1V RANGE2 (DISPLAY)
1V + 100V RANGE RLY (DISPLAY)
1 + 100V RNG
FOR USE WITH FUTURE OPTION
FILTER (DISPLAY)
B INVERTER
AXIS CROSSING RECEIVER
AXIS
GUARD
6 MHz CLOCK OSCILLATOR
6 MHz FOR 60 Hz OPERATION
5 MHz FOR 50 Hz
CLOCK BUFFERING
FOR 60 Hz OPERATION
220 pF FOR 50 Hz
6 MHz CLOCK
÷ 10 PROGRAM CLOCK
600 kHz
PROGRAM ADVANCE DECODING
PROGRAM ADVANCE GATE
POLARITY F/F
AXIS F/F
CLEAR F/F
PROGRAM COUNTER
READ CONTROL (FRONT PANEL)
READ COMMAND
READ RATE OSCILLATOR
Δ DELAY (1 MSEC)
ϵ DELAY (5 MSEC)
READY
DATA READY OUTPUT
SYSTEM READY
PROG RESET
RESET PULSE TO INTEGRATOR
SIGNAL INTEGRATE PULSES TO INTEGRATOR
SIGNAL
SIG INT
SUPERFAST GATING
SUPERFAST IN (PRINTER)
SUPERFAST (PROG)
SUPERFAST
200 COUNT DELAY LOGIC
COUNTER CLEAR LOGIC
200 COUNT
40 COUNT
8 COUNT
COUNT 1'S
COUNT 10'S
COUNT 100'S
CLEAR 1'S
CLEAR 10'S
CLEAR 100'S
PROG A-E

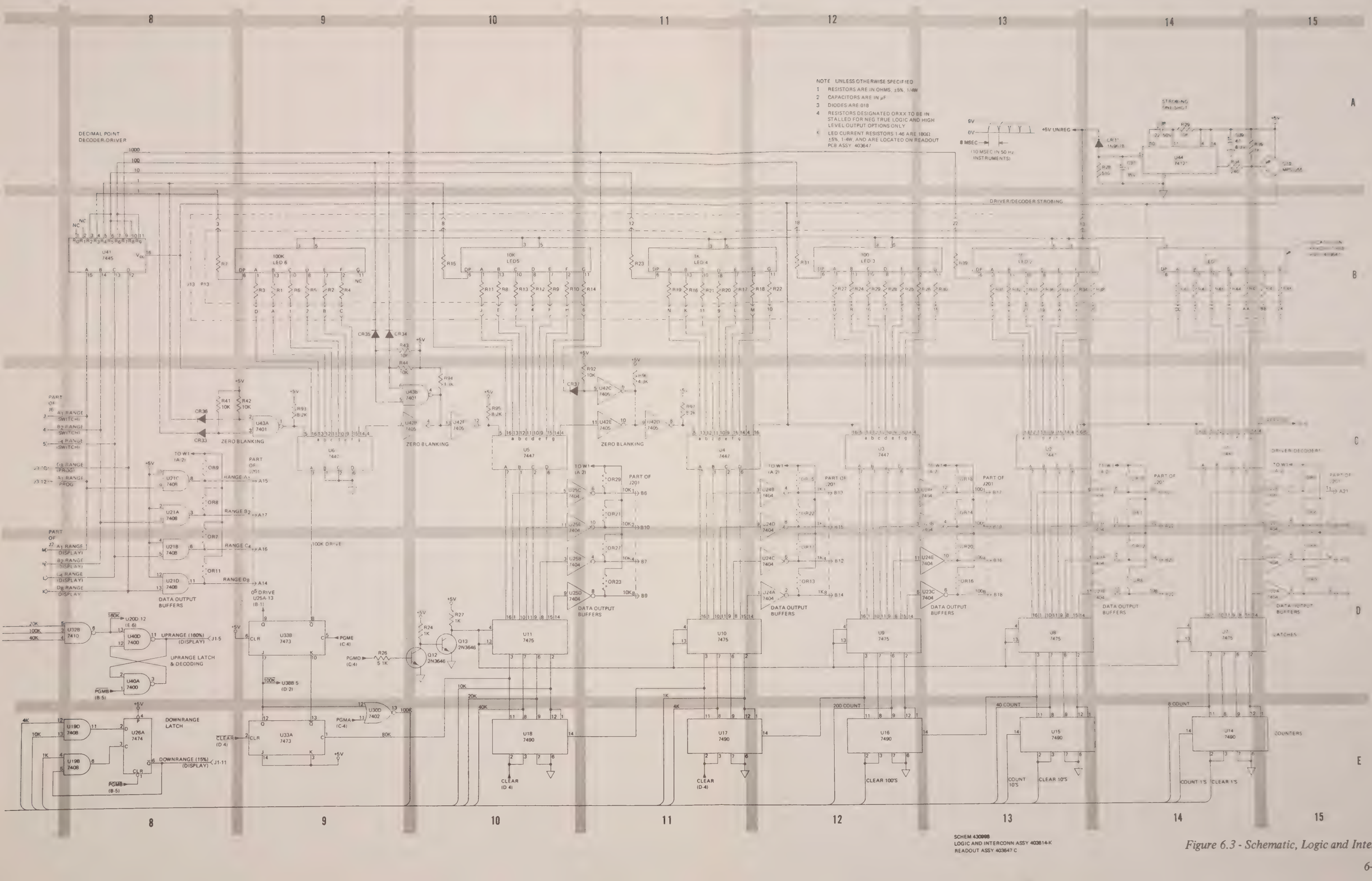

NOTE UNLESS OTHERWISE SPECIFIED
1 RESISTORS ARE IN OHMS, ±5%, 1/4W
2 CAPACITORS ARE IN µF
3 DIODES ARE 018
4 RESISTORS DESIGNATED ORXX TO BE INSTALLED FOR NEG TRUE LOGIC AND HIGH LEVEL OUTPUT OPTIONS ONLY
5 LED CURRENT RESISTORS 1-46 ARE 180Ω ±5%, 1-4W, AND ARE LOCATED ON READOUT PCB ASSY 403647
DECIMAL POINT DECODER/DRIVER
DRIVER/DECODER STROBING
STROBING ONE-SHOT
+5V UNREG
(10 MSEC IN 50 Hz INSTRUMENTS)
DATA OUTPUT BUFFERS
ZERO BLANKING
DOWNRANGE LATCH
UPRANGE LATCH & DECODING
LATCHES
COUNTERS
DRIVER/DECODERS
SCHEM 430998
LOGIC AND INTERCONN ASSY 403814-K
READOUT ASSY 403647 C

Figure 6.3 - Schematic, Logic and Interconnection

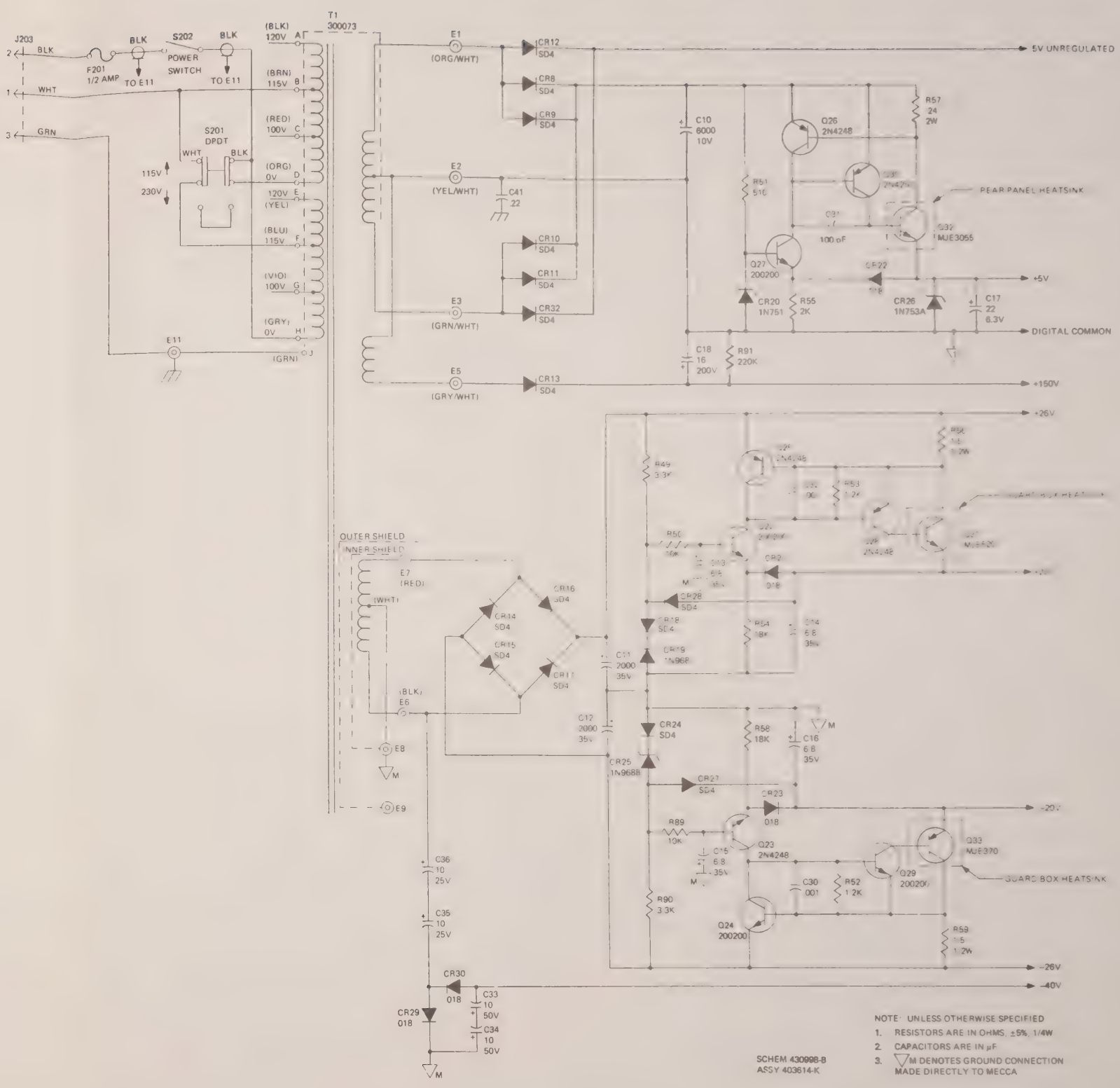
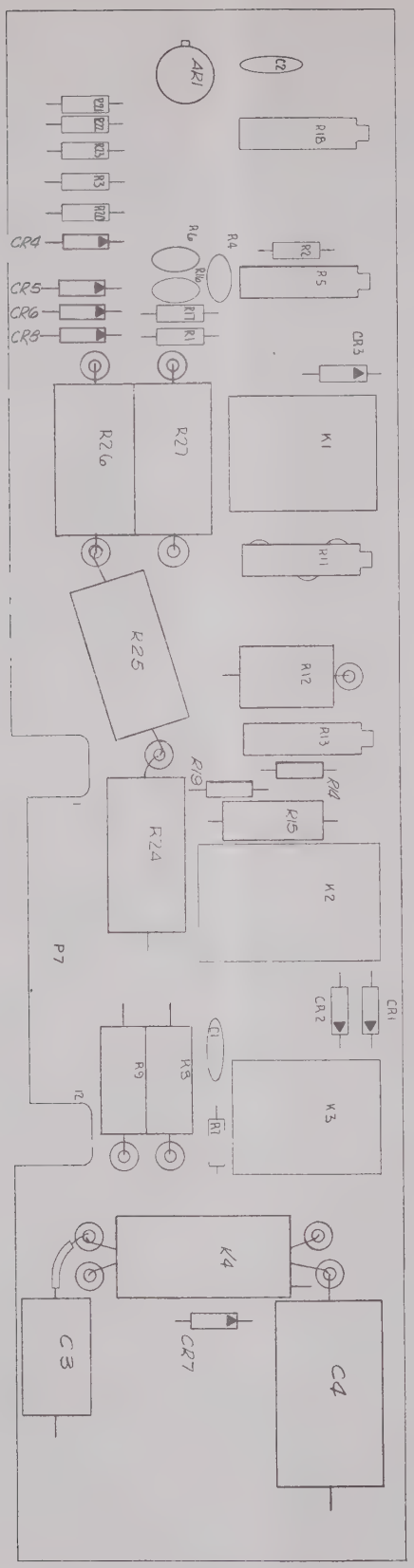
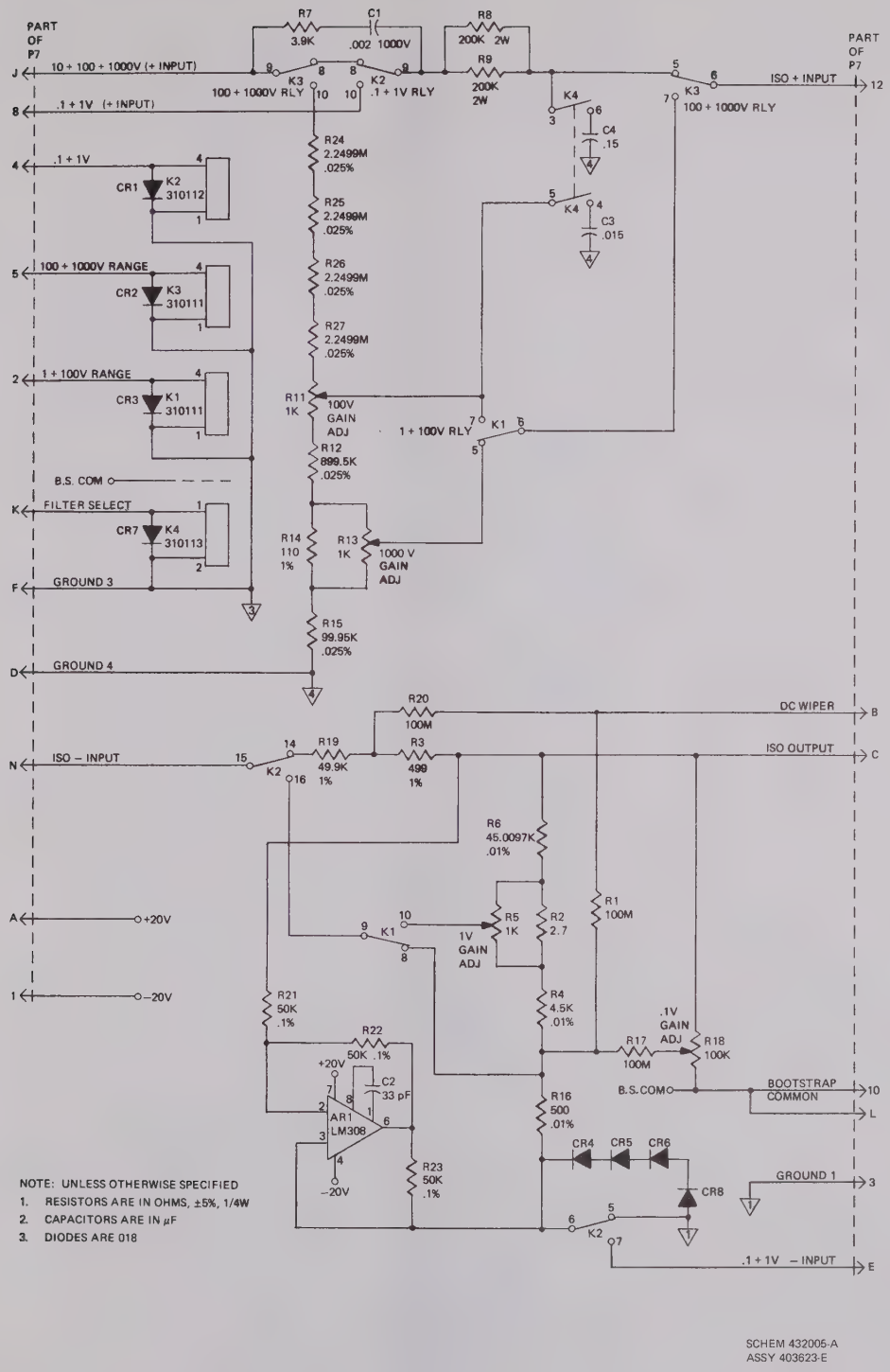


Figure 6.4 - Schematic, Power Supply



403623-E

Figure 6.5 - Layout, Attenuator



SCHEM 432005-A
ASSY 403623-E

Figure 6.6 - Schematic, Attenuator

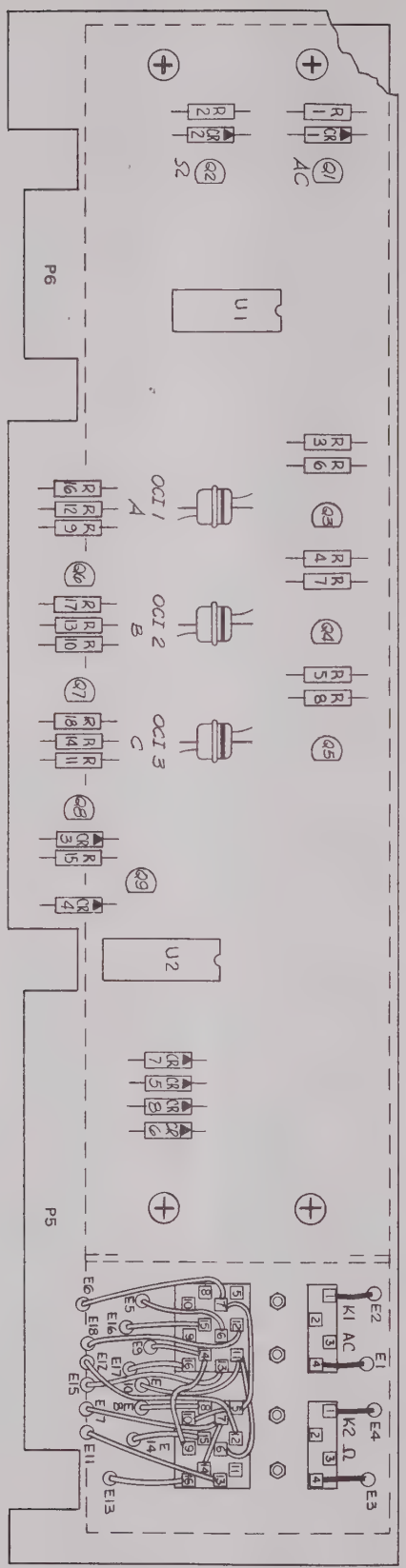


Figure 6.7 - Layout, Switching

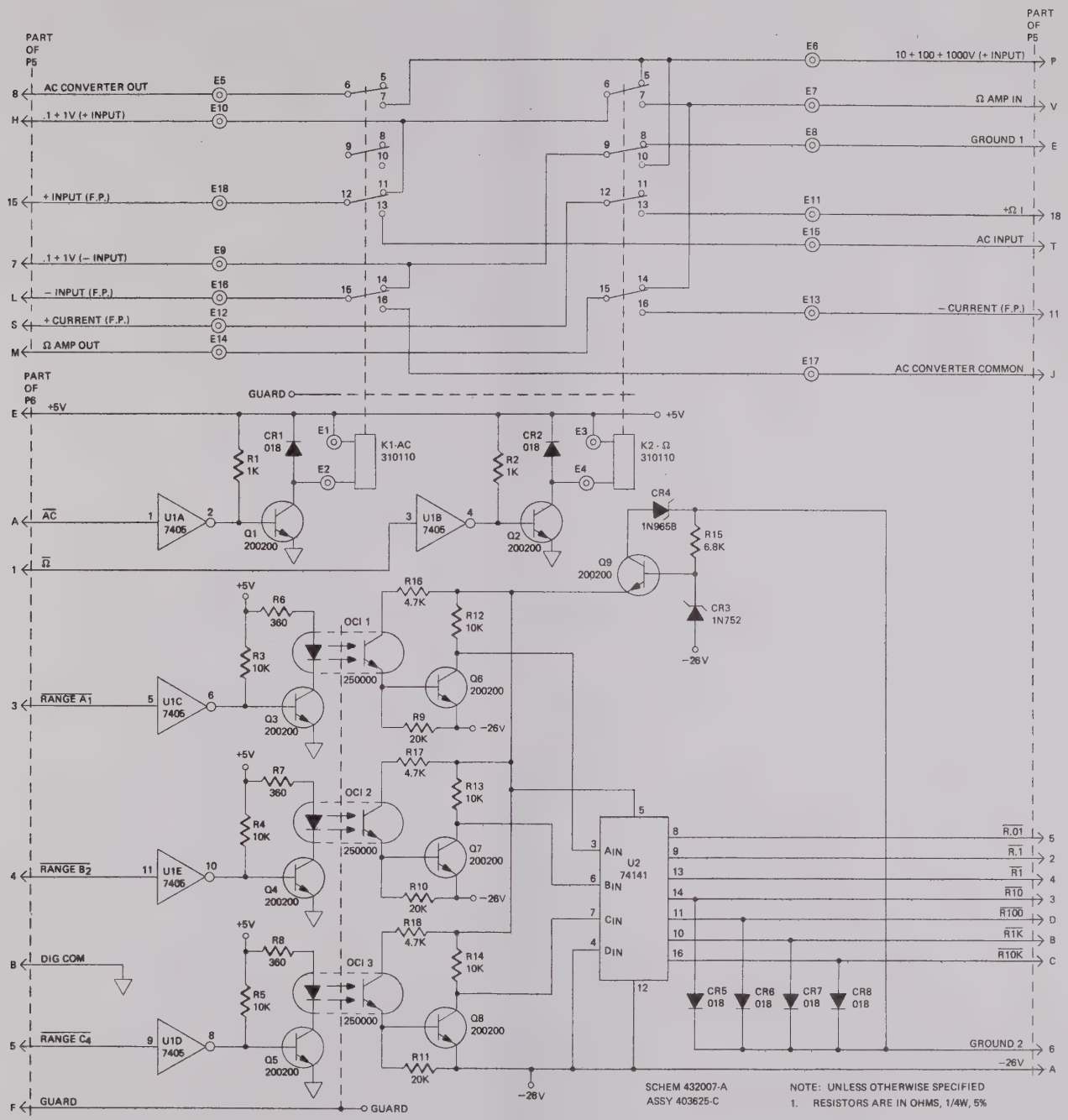
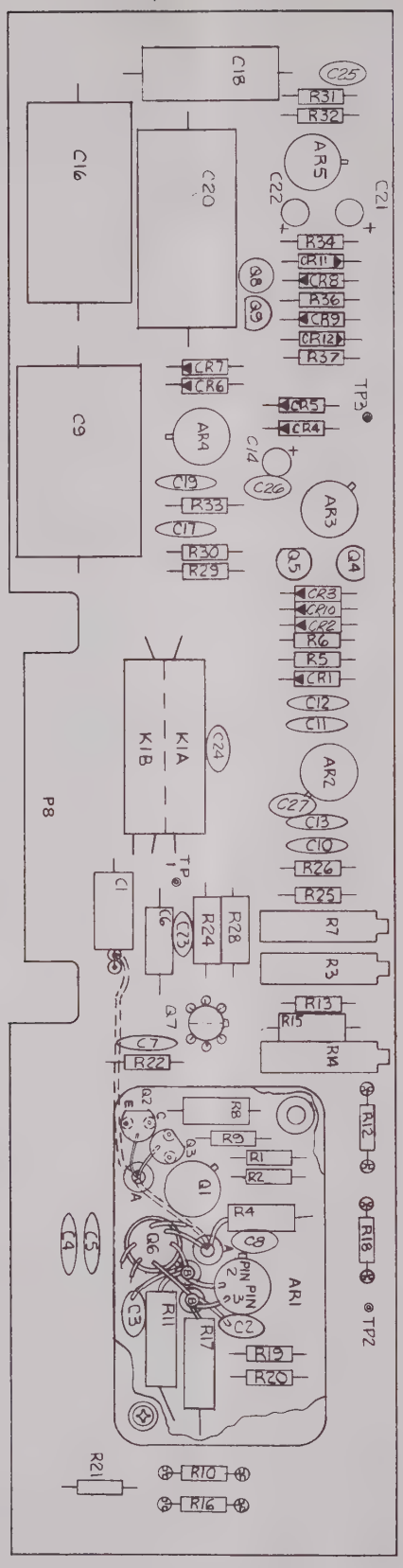
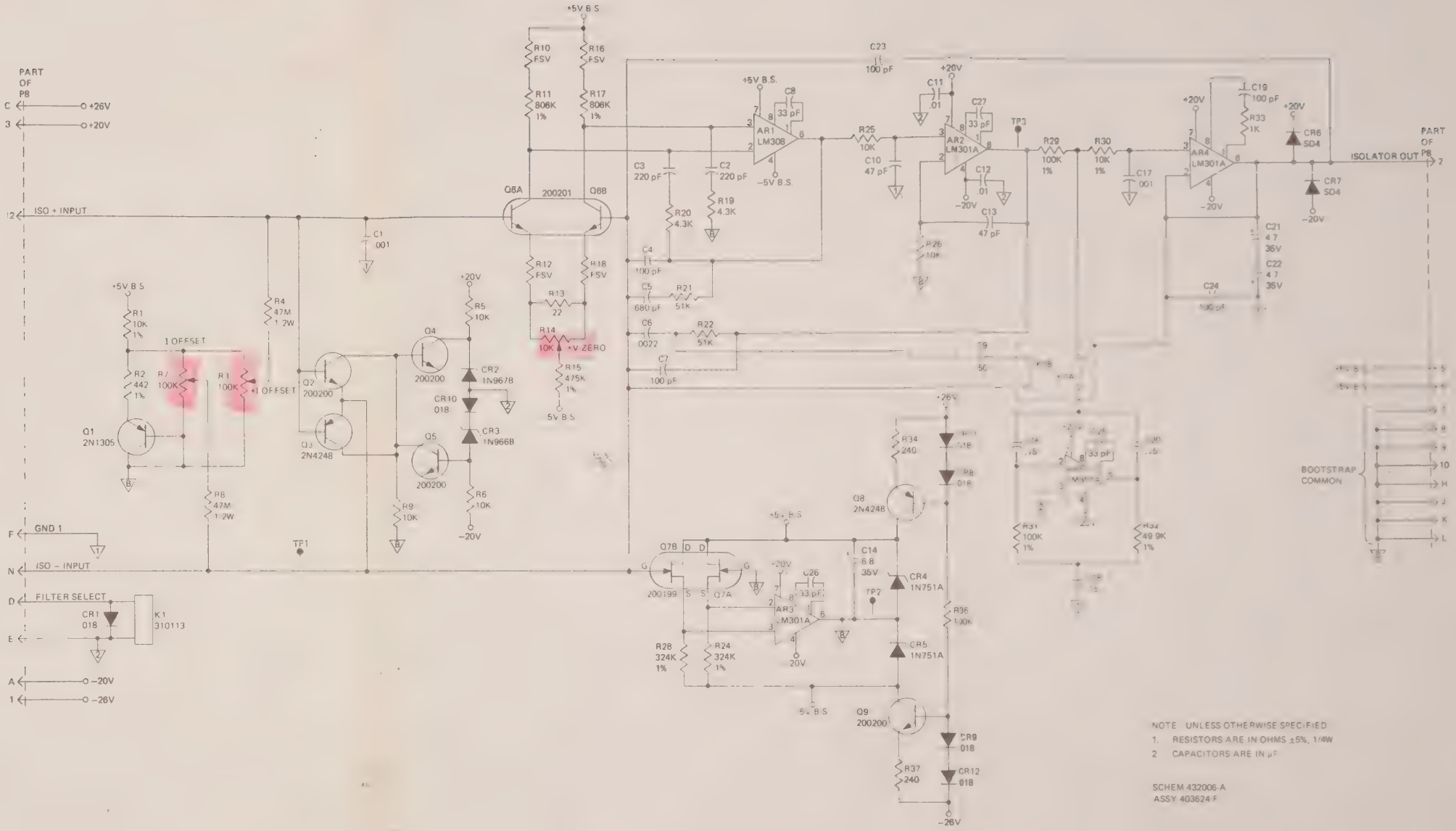


Figure 6.8 - Schematic, Switching



403624-F

Figure 6.9 - Layout, Isolator



NOTE UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE IN OHMS ±5%, 1/4W
2 CAPACITORS ARE IN μF

SCHEM 432006-A
ASSY 403624-F

Figure 6.10 - Schematic, Isolator

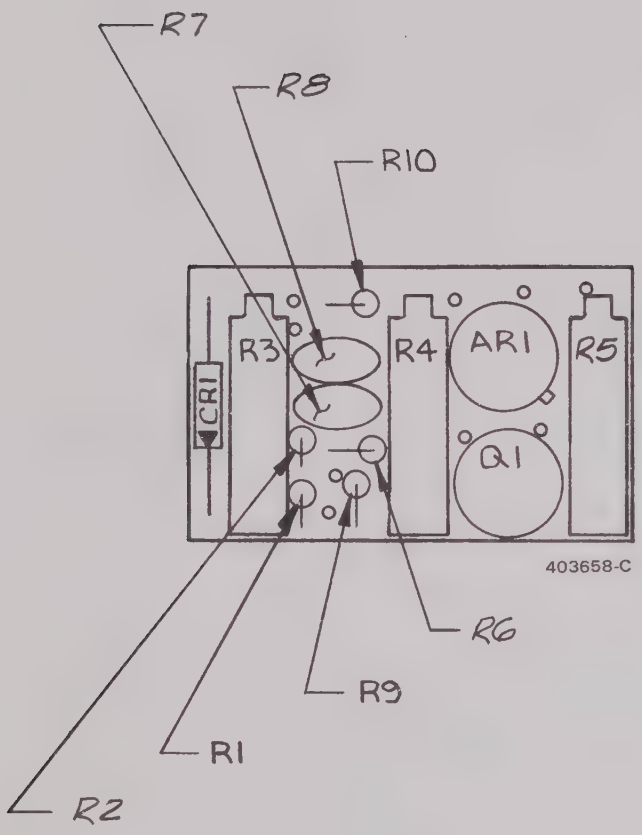


Figure 6.11 - Layout, 10V Reference Amplifier

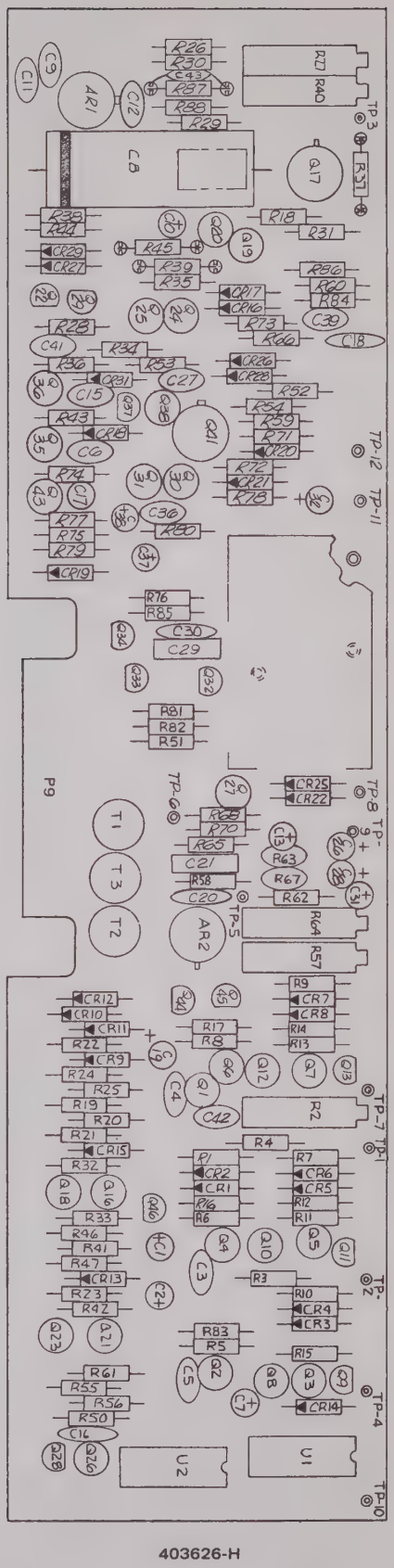
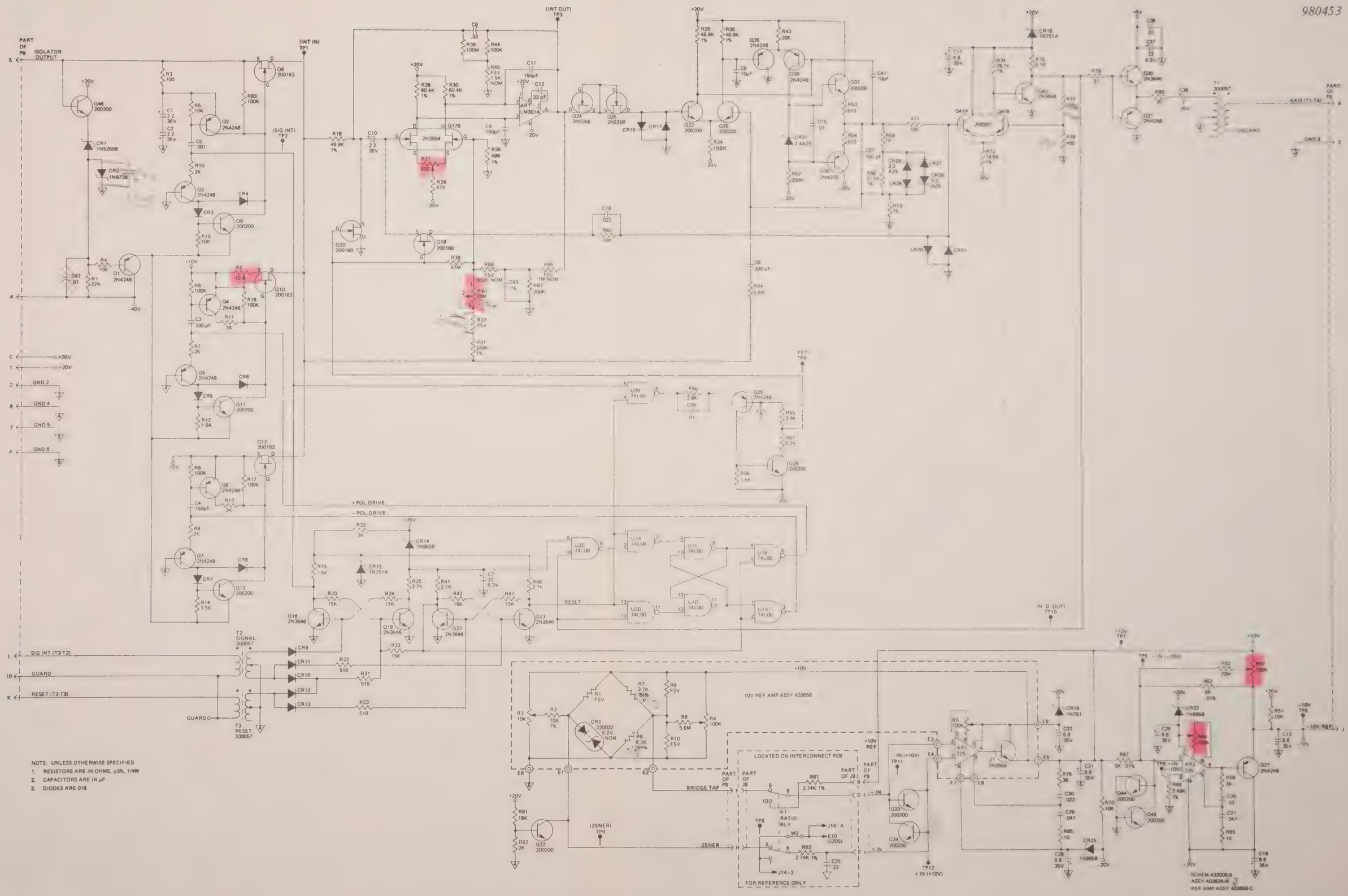


Figure 6.12 - Layout, Digitizer



NOTE: UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE IN OHMS, ±5%, 1/4W
2. CAPACITORS ARE IN µF
3. DIODES ARE 018

Figure 6.13 - Schematic, Digitizer and 10V Reference Amplifier

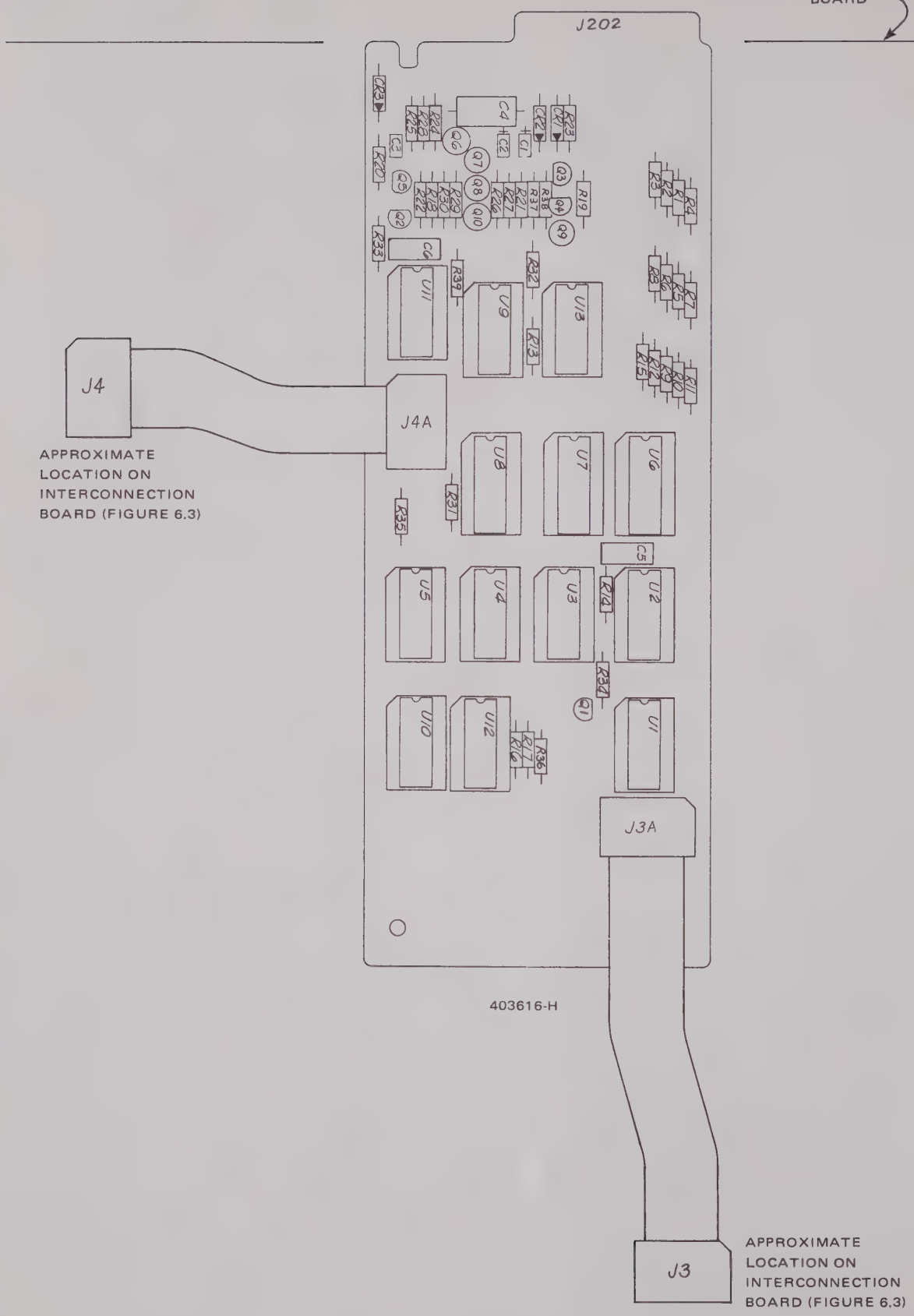


Figure 6.14 - Layout, Program

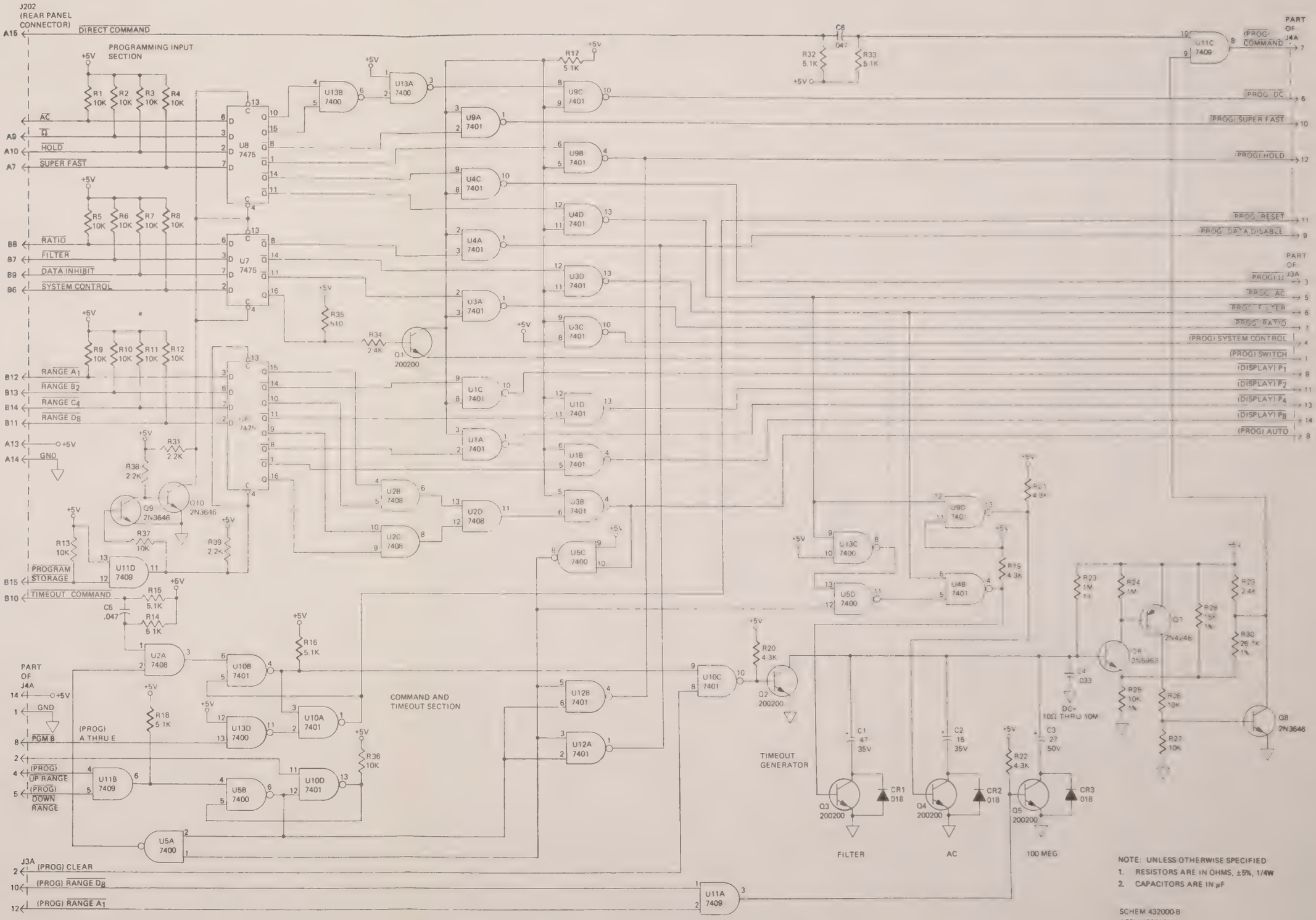


Figure 6.15 - Schematic, Program

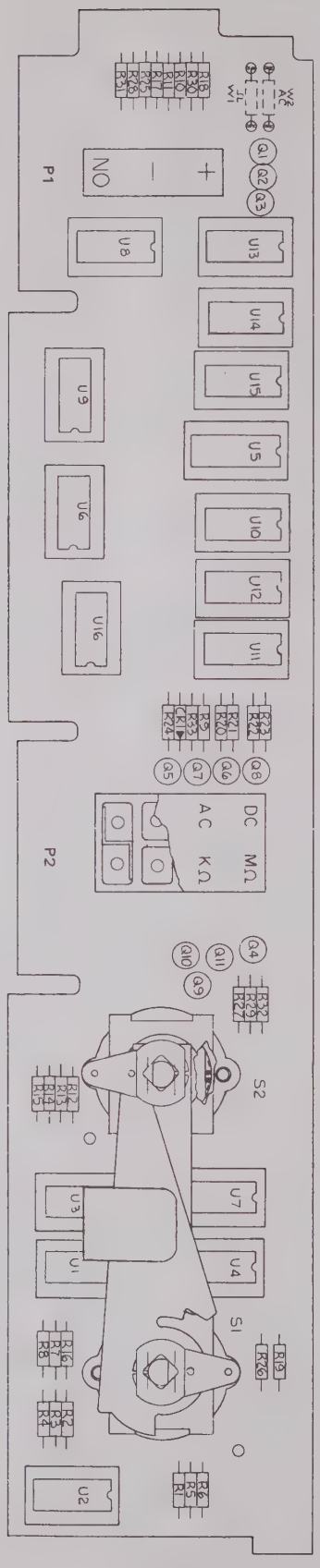


Figure 6.16 - Layout, Display

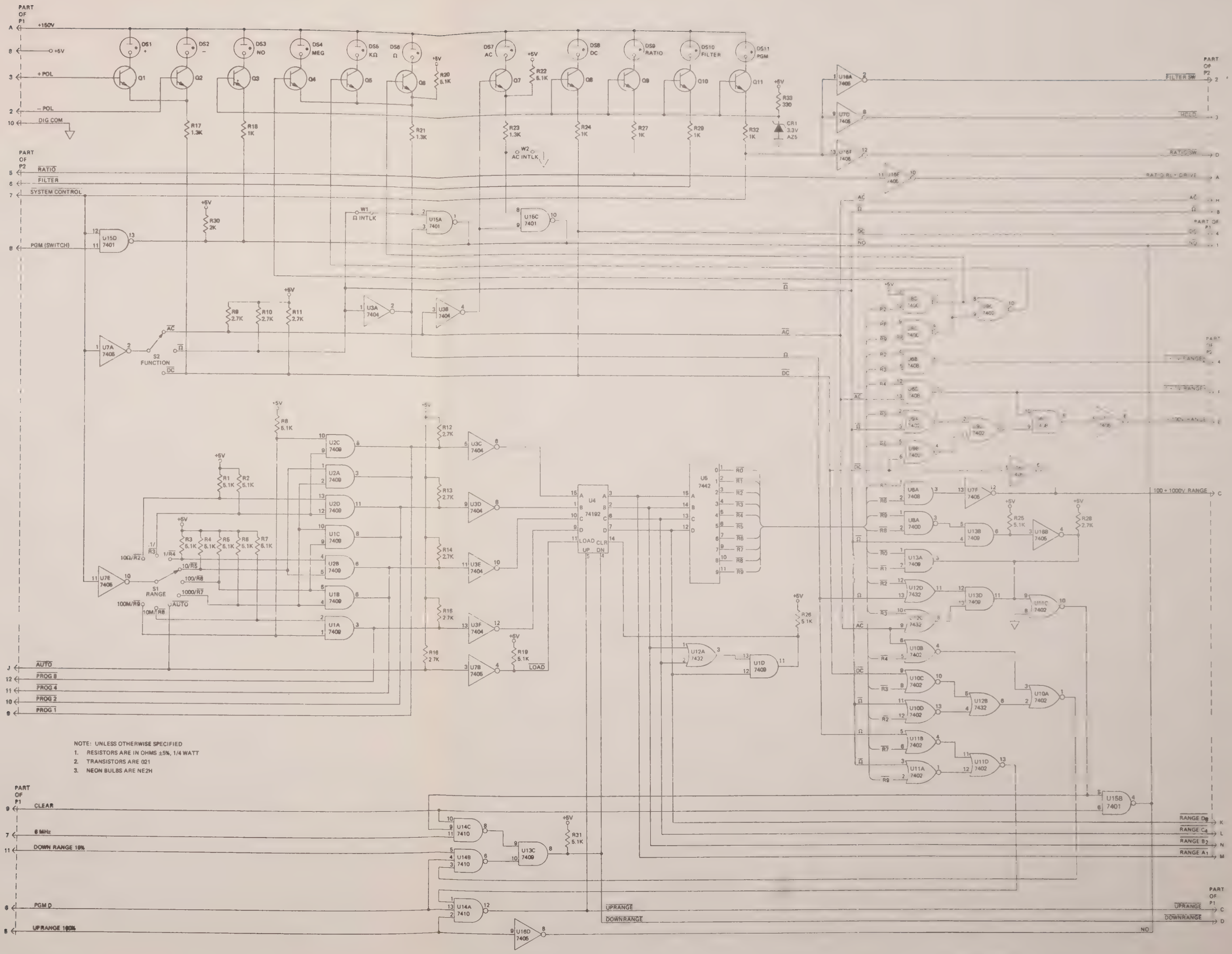
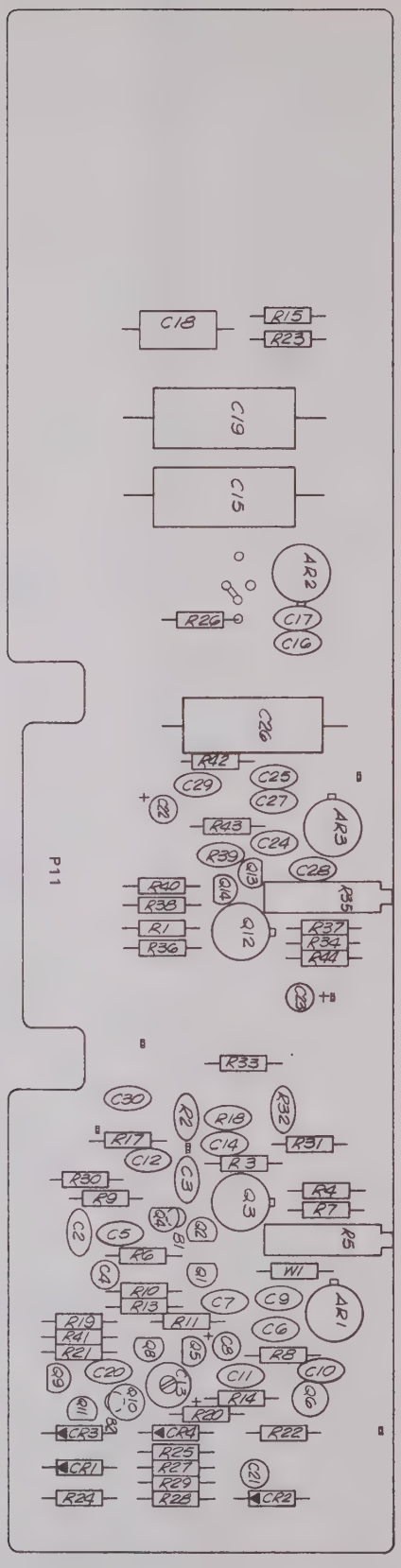


Figure 6.17 - Schematic, Display



403667-C

Figure 6.18 - Layout, AC Converter

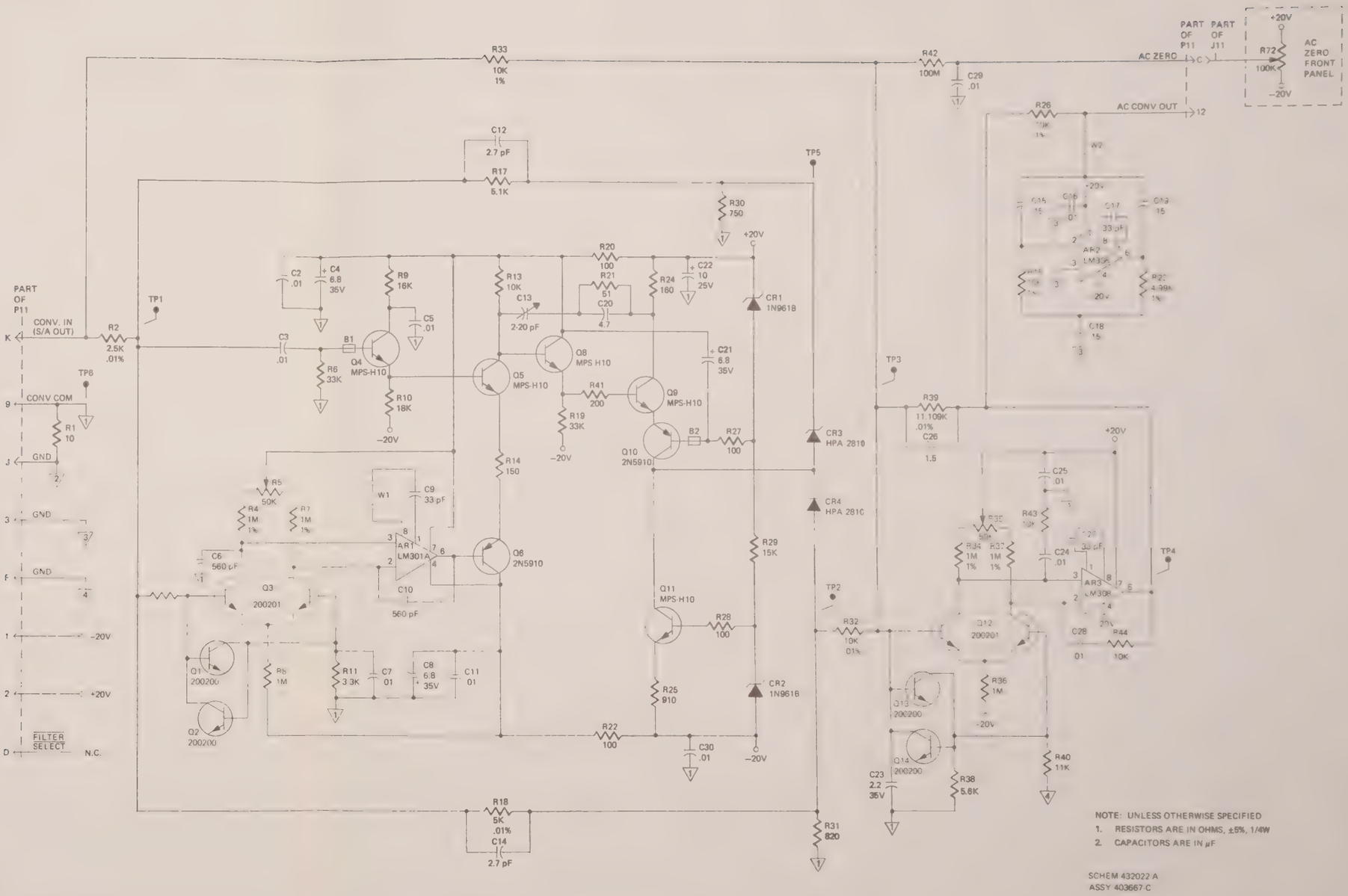
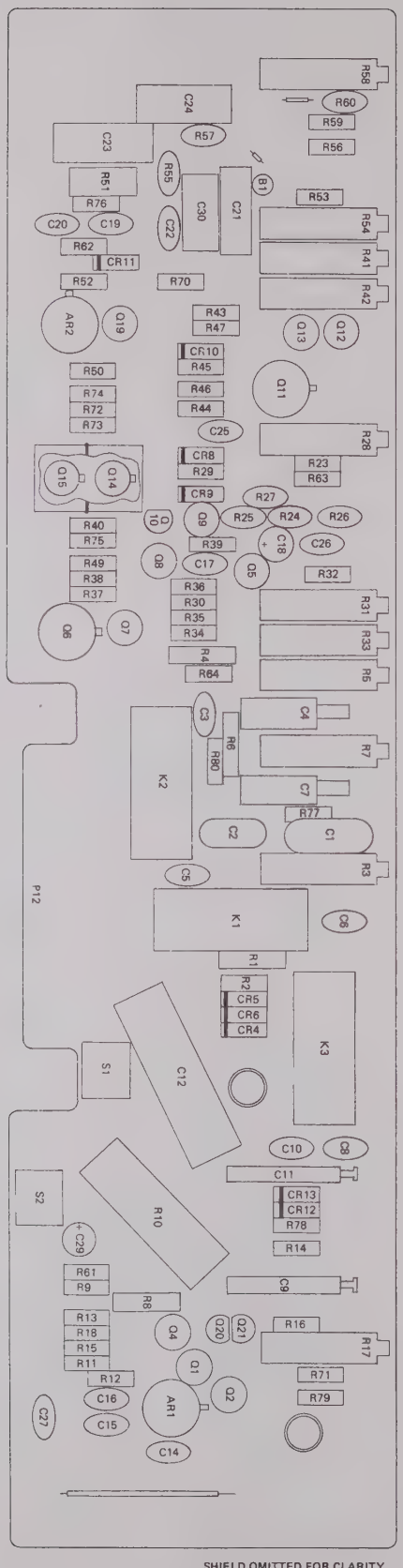


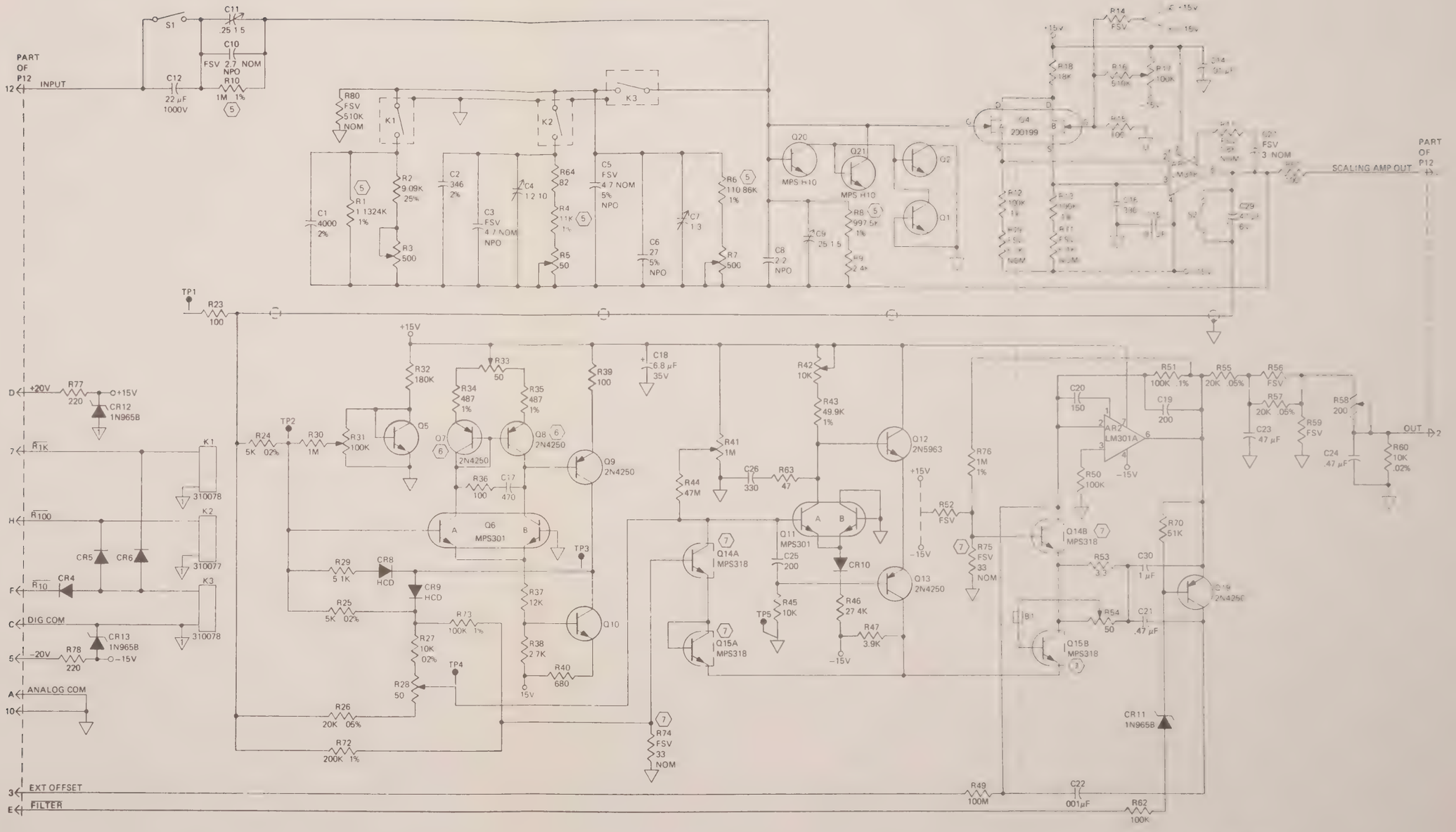
Figure 6.19 - Schematic, AC Converter



SHIELD OMITTED FOR CLARITY

403774

Figure 6.20 - Layout, RMS Converter

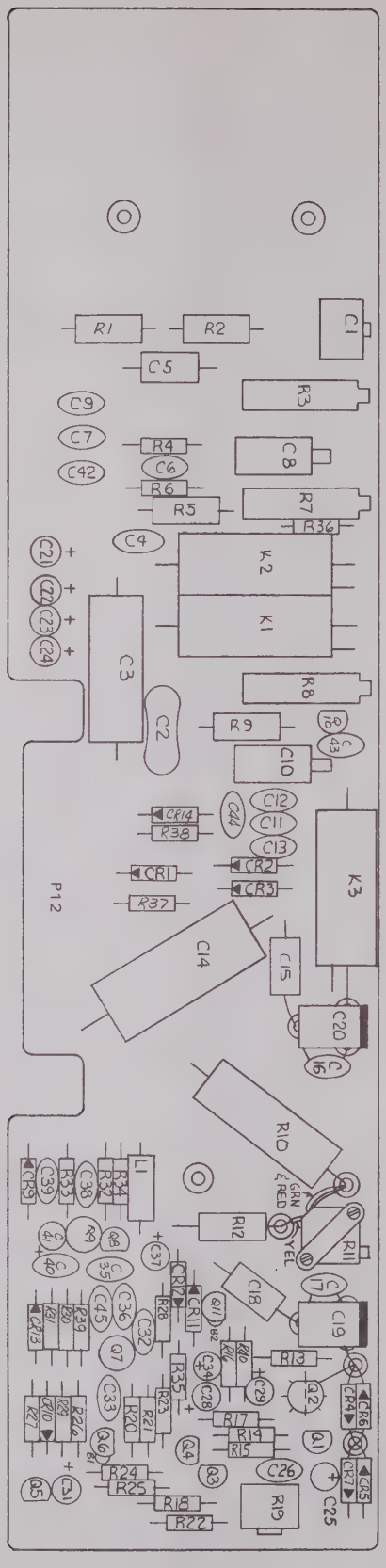


7. Q14, Q15, R74, AND R75 ARE LOGIC TRANSISTOR KIT 403819
6. Q7 AND Q8 ARE MATCHED PAIR 200112
5. R1, R4, R6, R8, AND R10 ARE RESISTOR SET 010721
4. TRANSISTORS ARE 200200
3. DIODES ARE 018
2. CAPACITORS ARE IN pF
1. RESISTORS ARE IN OHMS, ±5%, 1/4W

NOTES: UNLESS OTHERWISE SPECIFIED

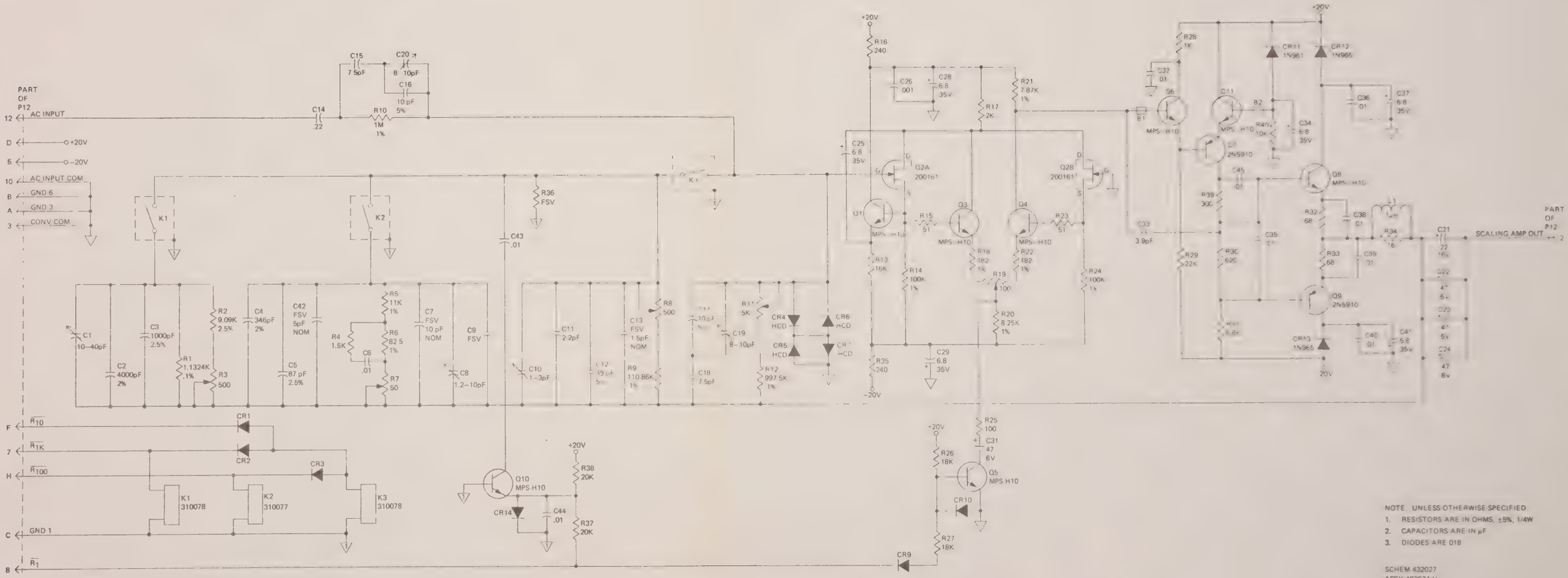
SCHEM 432056
ASSY 403774

Figure 6.21 - Schematic, RMS Converter



403674-H

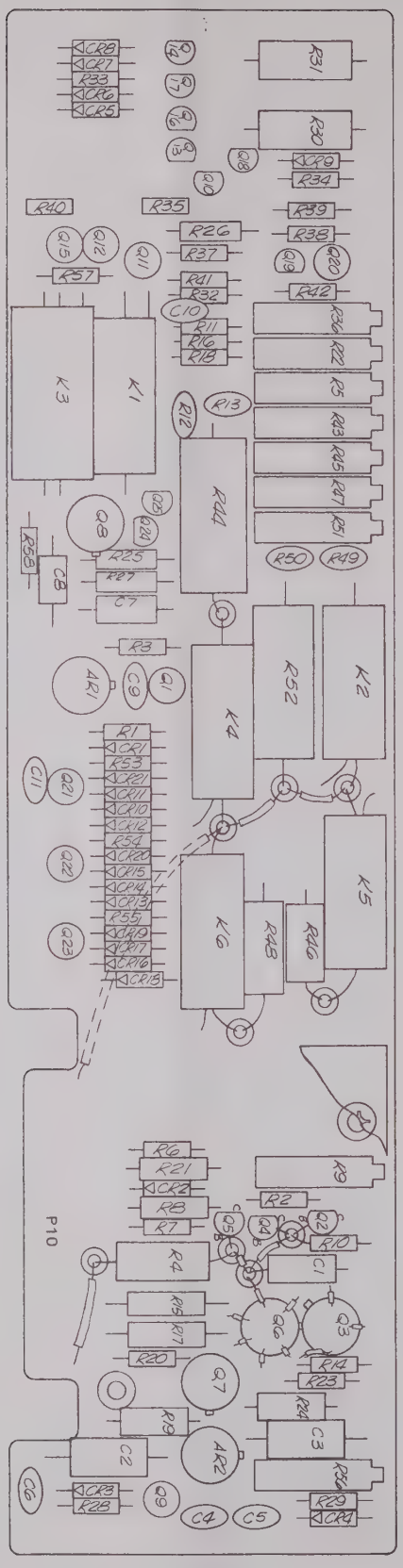
Figure 6.22 - Layout, Scaling Amplifier



NOTE: UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE IN OHMS, ±5%, 1/4W
2. CAPACITORS ARE IN μF
3. DIODES ARE 018

SCHEM 432027
ASSY 403674-H

Figure 6.23 - Schematic, Scaling Amplifier



403627-J

Figure 6.24 - Layout, Ohms Converter

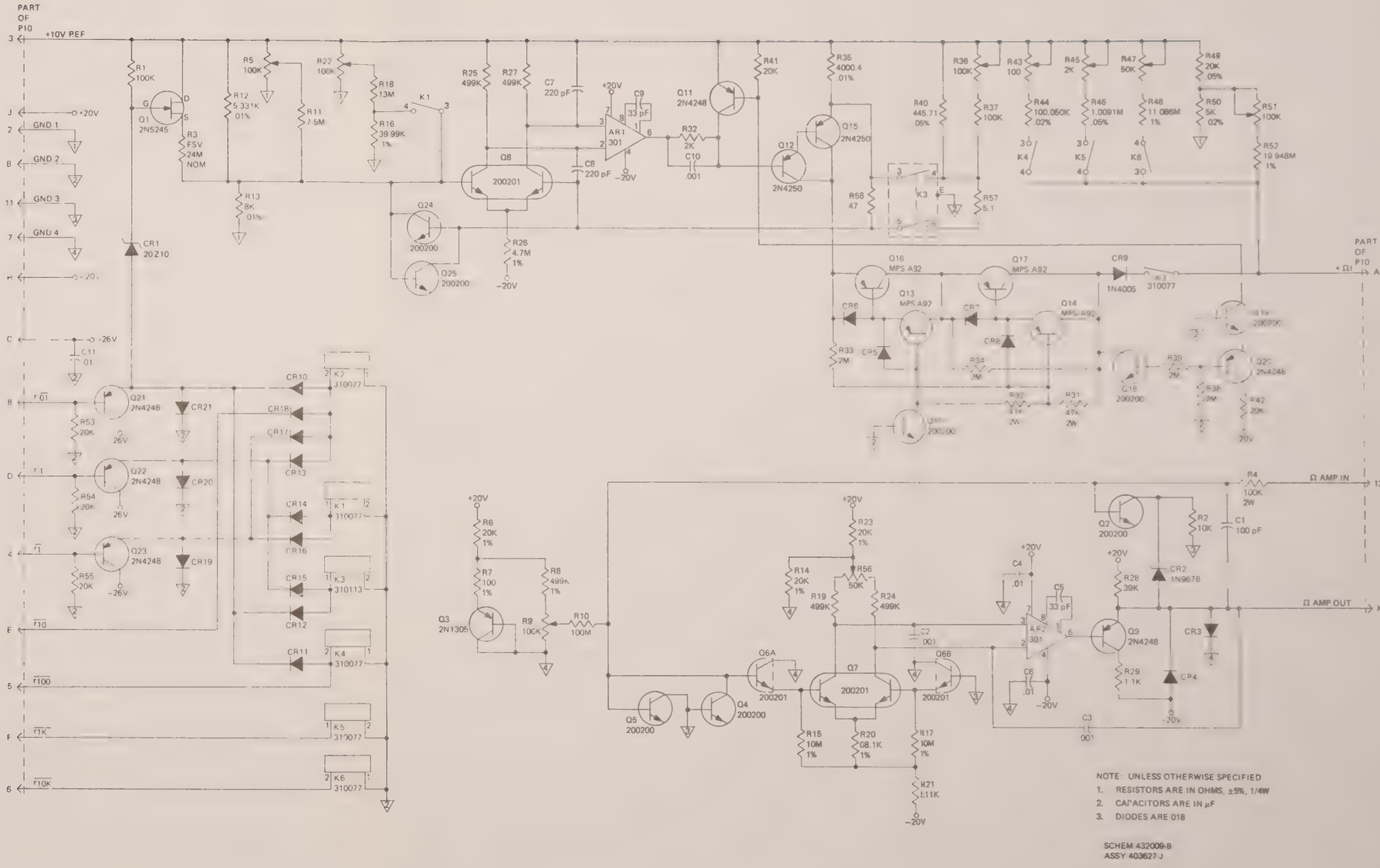


Figure 6.25 - Schematic, Ohms Converter

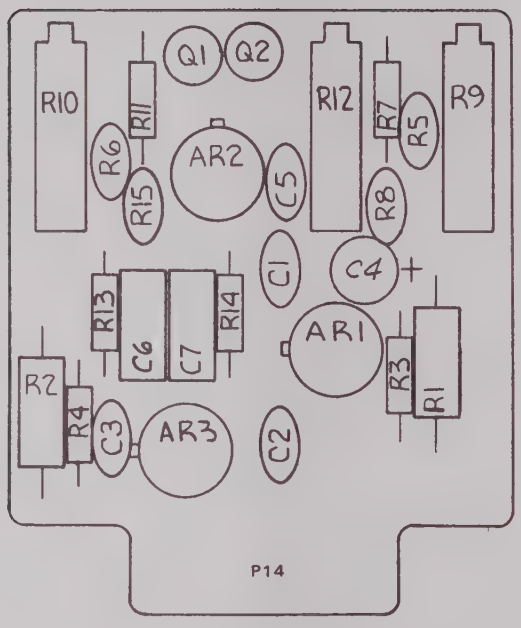


Figure 6.26 - Layout, 4-Wire Ratio

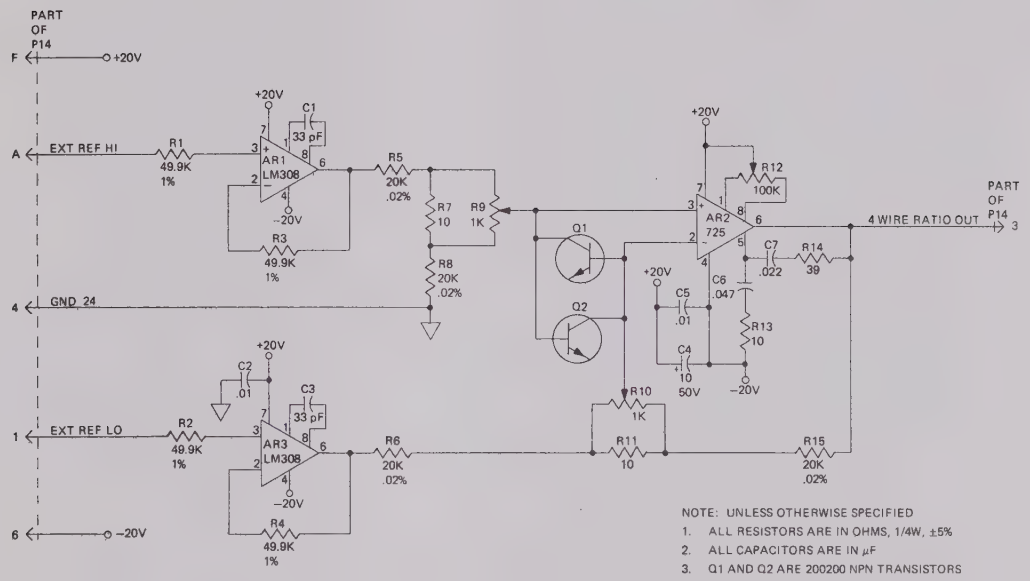


Figure 6.27 - Schematic, 4-Wire Ratio

SECTION 7 PARTS LIST

7.1 This section contains lists of replaceable parts arranged in the order of the following subassemblies:

	Page
Logic & Interconnection	7-3
Readout	7-10
Attenuator	7-12
Switching	7-14
Isolator	7-16
10V Reference	7-19
Digitizer	7-20
Program	7-26
Display	7-28
AC Converter	7-30
RMS Converter	7-33
Scaling Amplifier	7-37
Ohms Converter	7-40
4-Wire Ratio	7-44

7.2 Manufacturers are identified by FSC numbers listed in table 7.2, "List of Suppliers". The code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1, H4-2, and their supplements.

7.3 Certain parts having 21793 (Dana) listed in the "FSC" column are specially-selected semiconductors. For some of these, standard commercial parts will serve as satisfactory replacements. These Dana parts are identified in table 7.1 along with the commerical equivalent.

Table 7.1

Semiconductor Type:	Equivalent:
018 Diode	Texas Instruments 1N4448
021 Transistor	MPS A92

Table 7.2 - List of Suppliers

FSC	NAME	FSC	NAME
01121	ALLEN BRADLEY CO. MILWAUKEE, WISCONSIN	02114	FERROXCUBE CORP. SAUGERTIES, NEW YORK
01295	TEXAS INSTRUMENTS, INC. (Components Group) DALLAS, TEXAS	03888	PYROFILM CORP. WHIPPANY, NEW JERSEY
02111	SPECTROL ELECTRONICS CORP. CITY OF INDUSTRY, CALIFORNIA	04713	MOTOROLA, INC. (Semiconductor Products Division) PHOENIX, ARIZONA

Table 7.2 - List of Suppliers (continued)

FSC	NAME
05397	UNION CARBIDE CORP. (Materials Systems Division) CLEVELAND, OHIO
07263	FAIRCHILD SEMICONDUCTOR (Division of Fairchild Camera & Instrument Corp.) MOUNTAIN VIEW, CALIFORNIA
07716	TRW ELECTRONIC COMPONENTS (IRC) BURLINGTON, IOWA
08257	NPC ELECTRONICS CANOGA PARK, CALIFORNIA
09023	CORNELL-DUBILIER ELECTRONICS (Division Federal Pacific Electric Co.) SANFORD, NORTH CAROLINA
12060	DIODES, INC. CHATSWORTH, CALIFORNIA
13571	ELECTRONIC RESEARCH CO. OVERLAND PK., KANSAS
15636	ELEC-TROL, INC. SAUGUS, CALIFORNIA
17856	SILICONIX, INC. SANTA CLARA, CALIFORNIA
18612	VISHAY RESISTOR PRODUCTS (Division Vishay Intertechnology, Inc.) MALVERN, PENNSYLVANIA
21793	DANA LABORATORIES, INC. IRVINE, CALIFORNIA
22045	JORDAN ELECTRIC CO. VAN NUYS, CALIFORNIA
27014	NATIONAL SEMI-CONDUCTOR CORP. SANTA CLARA, CALIFORNIA
27556	IMB ELECTRONIC PRODUCTS, INC. SANTA FE SPRINGS, CALIFORNIA
50434	HEWLETT-PACKARD CO. (HP Associates) PALO ALTO, CALIFORNIA
50522	MONSANTO CO. (Electronic Special Products) CUPERTINO, CALIFORNIA
56289	SPRAGUE ELECTRIC CO. (Pacific Division) LOS ANGELES, CALIFORNIA
71468	ITT CANNON ELECTRIC SANTA ANA, CALIFORNIA
71471	AEROVOX CORP. (Cinema Plant) MONCKS CORNER, SOUTH CAROLINA
71590	CENTRALAB ELECTRONICS (Division of Globe-Union, Inc.) MILWAUKEE, WISCONSIN
71785	TRW ELECTRONIC COMPONENTS (Cinch Division) ELK GROVE VILLAGE, ILLINOIS
72136	ELECTRO MOTIVE MFG. CO., INC. WILLIMANTIC, CONNECTICUT
73138	BECKMAN INSTRUMENTS, INC. (Helipot Division) FULLERTON, CALIFORNIA
73445	AMPEREX ELECTRONIC CORP. HICKSVILLE, LONG ISLAND, NEW YORK
76493	J. W. MILLER CO. COMPTON, CALIFORNIA
77342	AMERICAN MACHINE & FOUNDRY CO. (Potter & Brumfield Division) PRINCETON, INDIANA
80131	ELECTRONICS INDUSTRIES ASSOC. WASHINGTON, D. C.
81349	MILITARY SPECIFICATION
87730	UNITED MINERAL & CHEMICAL CORP. NEW YORK CITY, NEW YORK
89110	AMP, INC. (Capitron Division) ELIZABETHTOWN, PENNSYLVANIA
91293	JOHANSON MFG. CO. BOONTON, NEW JERSEY
91637	DALE ELECTRONICS, INC. COLUMBUS, NEBRASKA
95275	VITRAMON, INC. BRIDGEPORT, CONNECTICUT
99800	AMERICAN PRECISION INDUSTRIES, INC. (Delevan Division) EAST AURORA, NEW YORK

403614 – Assy., PCB, LOGIC & INTERCONNECTION (Figure 6.3)

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
C1	110126	CAP	TANTA	6.8 MFD	35 V		71468	4321217168
C2	130142	CAP		150 PFD		5%	72136	DM5-151J
C3	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C4	110129	CAP	TANTA	.1 MFD	35 V		71468	4321217010
C5	110129	CAP	TANTA	.1 MFD	35 V		71468	4321217010
C6	120310	CAP	POLY	.01 MFD	250 V	10%	73445	C280MAE/A10K
C7	110156	CAP	TANTA	4.7 MFD	6 V		05397	T360A475K006
C8	120308	CAP		.047 MFD	250 V	10%	73445	C280MAE/A47K
C10	110128	CAP	ELECT	6000 MFD	10 V		56289	36D602G010AA2A
C11	110067	CAP	ELECT	2000 MFD	35 V		87730	2000DXW35
C12	110067	CAP	ELECT	2000 MFD	35 V		87730	2000DXW35
C13	110126	CAP	TANTA	6.8 MFD	35 V		71468	4321217168
C14	110126	CAP	TANTA	6.8 MFD	35 V		71468	4321217168
C15	110126	CAP	TANTA	6.8 MFD	35 V		71468	4321217168
C16	110126	CAP	TANTA	6.8 MFD	35 V		71468	4321217168
C17	110127	CAP	TANTA	22 MFD	6.3 V		71468	4321212222
C18	110066	CAP	ELECT	16 MFD	200 V		73445	C436AR/L16
C19	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C20	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C21	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C22	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C23	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C24	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C25	120290	CAP	MYLAR	.22 MFD	100 V	20%	73445	C281AH/A220K
C29	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C30	101174	CAP	CERAM	.001 MFD	500 V	10%	71471	SCD3X5F
C31	101145	CAP	CERAM	100 PFD		10%	71471	ETCD-DI-1(N5600)
C32	101174	CAP	CERAM	.001 MFD	500 V	10%	71471	SCD3X5F
C33	110158	CAP	TANTA	10 MFD	50 V		05397	K10E50
C34	110158	CAP	TANTA	10 MFD	50 V		05397	K10E50
C35	110151	CAP	TANTA	10 MFD	25 V	20%	05397	K10E25
C36	110151	CAP	TANTA	10 MFD	25 V	20%	05397	K10E25
C37	110143	CAP	TANTA	1 MFD	35 V		05397	K1E35
C38	110148	CAP	TANTA	.22 MFD	50 V	10%	05397	T368A224K050
C39	110140	CAP	TANTA	47 MFD	6.3 V		71468	4321212247
C40	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C41	120090	CAP	MYLAR	.22 MFD	600 V	5%	27556	ZA1101J
C42	120308	CAP		.047 MFD	250 V	10%	73445	C280MAE/A47K
CR1	211083	DIODE	SILICO		018		21793	211083
CR3	211083	DIODE	SILICO		018		21793	211083
CR8	210004	DIODE	SILICO		SD4		12060	SD4
CR9	210004	DIODE	SILICO		SD4		12060	SD4

403614 – Assy., PCB, LOGIC & INTERCONNECTION *continued*

REF DES	DANA P/N	DESCRIPTION				FSC	MANU P/N
CR10	210004	DIODE	SILICO		SD4	12060	SD4
CR11	210004	DIODE	SILICO		SD4	12060	SD4
CR12	210004	DIODE	SILICO		SD4	12060	SD4
CR13	210004	DIODE	SILICO		SD4	12060	SD4
CR14	210004	DIODE	SILICO		SD4	12060	SD4
CR15	210004	DIODE	SILICO		SD4	12060	SD4
CR16	210004	DIODE	SILICO		SD4	12060	SD4
CR17	210004	DIODE	SILICO		SD4	12060	SD4
CR18	210004	DIODE	SILICO		SD4	12060	SD4
CR19	220011	DIODE	SILICO	ZENER	1N968A	81349	1N968A
CR20	220007	DIODE	SILICO	ZENER	1N751A	81349	1N751A
CR21	211083	DIODE	SILICO		018	21793	211083
CR22	211083	DIODE	SILICO		018	21793	211083
CR23	211083	DIODE	SILICO		018	21793	211083
CR24	210004	DIODE	SILICO		SD4	12060	SD4
CR25	220011	DIODE	SILICO	ZENER	1N968A	81349	1N968A
CR26	220040	DIODE		ZENER	1N753A	81349	1N753A
CR27	210004	DIODE	SILICO		SD4	12060	SD4
CR28	210004	DIODE	SILICO		SD4	12060	SD4
CR29	211083	DIODE	SILICO		018	21793	211083
CR30	211083	DIODE	SILICO		018	21793	211083
CR31	220049	DIODE		ZENER	1N957B	81349	1N957B
CR32	210004	DIODE	SILICO		SD4	12060	SD4
CR33	211083	DIODE	SILICO		018	21793	211083
CR34	211083	DIODE	SILICO		018	21793	211083
CR35	211083	DIODE	SILICO		018	21793	211083
CR36	211083	DIODE	SILICO		018	21793	211083
CR37	211083	DIODE	SILICO		018	21793	211083
J1	453505	CONN	12 PIN		252-12-30-160	71785	252-12-30-160
J2	453505	CONN	12 PIN		252-12-30-160	71785	252-12-30-160
J5	600228	CONN	18 PIN		252-18-30-160	71785	252-18-30-160
J6	600671	CONN	6 PIN		50-12B-10	71785	50-12B-10
J7	600280	CONN	12 PIN		252-12-30-160	71785	252-12-30-160
J8	600280	CONN	12 PIN		252-12-30-160	71785	252-12-30-160
J9	600670	CONN	10 PIN		50-20B-10	71785	50-20B-10
J10	600280	CONN	12 PIN		252-12-30-160	71785	252-12-30-160
J11	600280	CONN	12 PIN		252-12-30-160	71785	252-12-30-160
J12	600280	CONN	12 PIN		252-12-30-160	71785	252-12-30-160
J13	600575	CONN	25 PIN		252-25-30-160	71785	252-25-30-160
K1	310109	RELAY			5 V	77342	R10E2515-1

403614 – Assy., PCB, LOGIC & INTERCONNECTION *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
L1	310055	CHOKE RF 4.7 μH 9310-28	76493	9310-28
OCI-1	250000	ISOLATOR OPTICALLY COUPLED	01295	TIL108
OCI-2	250000	ISOLATOR OPTICALLY COUPLED	01295	TIL108
OCI-3	250000	ISOLATOR OPTICALLY COUPLED	01295	TIL108
OCI-4	250000	ISOLATOR OPTICALLY COUPLED	01295	TIL108
Q1	200099	TRANS 2N4258	81349	2N4258
Q2	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q3	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q4	200099	TRANS 2N4258	81349	2N4258
Q5	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q6	200099	TRANS 2N4258	81349	2N4258
Q7	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q8	200200	TRANS NPN SKA8085	01295	SKA8085
Q9	200099	TRANS 2N4258	81349	2N4258
Q10	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q11	200136	TRANS 2N5963	81349	2N5963
Q12	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q13	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q14	200200	TRANS NPN SKA8085	01295	SKA8085
Q15	200200	TRANS NPN SKA8085	01295	SKA8085
Q16	200200	TRANS NPN SKA8085	01295	SKA8085
Q17	200200	TRANS NPN SKA8085	01295	SKA8085
Q18	200200	TRANS NPN SKA8085	01295	SKA8085
Q19	200167	TRANS MPSU55	04713	MPSU55
Q21	200200	TRANS NPN SKA8085	01295	SKA8085
Q22	200200	TRANS NPN SKA8085	01295	SKA8085
Q23	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q24	200200	TRANS NPN SKA8085	01295	SKA8085
Q25	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q26	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q27	200200	TRANS NPN SKA8085	01295	SKA8085
Q28	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q29	200200	TRANS NPN SKA8085	01295	SKA8085
Q30	200068	TRANS 2N4250	80131	2N4250
Q31	200155	TRANS MJE520	04713	MJE520
Q32	200130	TRANS MJE3055	04713	MJE3055
Q33	200154	TRANS MJE370	04713	MJE370
Q35	200200	TRANS NPN SKA8085	01295	SKA8085
Q37	200200	TRANS NPN SKA8085	01295	SKA8085
Q39	200200	TRANS NPN SKA8085	01295	SKA8085
Q41	200200	TRANS NPN SKA8085	01295	SKA8085
Q42	200200	TRANS NPN SKA8085	01295	SKA8085
Q43	200200	TRANS NPN SKA8085	01295	SKA8085

403614 – Assy., PCB, LOGIC & INTERCONNECTION *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R1	000391	RES CARBON 390 OHM 5% 1/4W	81349	RC07GF391J
R2	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R3	000121	RES CARBON 120 OHM 5% 1/4W	81349	RC07GF121J
R4	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R5	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R6	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R7	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R8	000201	RES CARBON 200 OHM 5% 1/4W	81349	RC07GF201J
R9	000201	RES CARBON 200 OHM 5% 1/4W	81349	RC07GF201J
R10	000200	RES CARBON 20 OHM 5% 1/4W	81349	RC07GF200J
R11	000200	RES CARBON 20 OHM 5% 1/4W	81349	RC07GF200J
R12	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R13	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R14	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R15	000204	RES CARBON 200 K 5% 1/4W	81349	RC07GF204J
R16	000303	RES CARBON 30 K 5% 1/4W	81349	RC07GF303J
R17	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R18	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R19	000432	RES CARBON 4.3 K 5% 1/4W	81349	RC07GF432J
R20	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R21	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R22	000154	RES CARBON 150 K 5% 1/4W	81349	RC07GF154J
R23	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R24	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R26	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R27	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R28	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R29	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R30	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R31	000182	RES CARBON 1.8 K 5% 1/4W	81349	RC07GF182J
R32	000361	RES CARBON 360 OHM 5% 1/4W	81349	RC07GF361J
R33	000182	RES CARBON 1.8 K 5% 1/4W	81349	RC07GF182J
R34	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R35	000361	RES CARBON 360 OHM 5% 1/4W	81349	RC07GF361J
R36	000182	RES CARBON 1.8 K 5% 1/4W	81349	RC07GF182J
R37	000361	RES CARBON 360 OHM 5% 1/4W	81349	RC07GF361J
R38	000182	RES CARBON 1.8 K 5% 1/4W	81349	RC07GF182J
R39	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R40	000361	RES CARBON 360 OHM 5% 1/4W	81349	RC07GF361J
R41	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R42	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R43	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J

403614 – Assy., PCB, LOGIC & INTERCONNECTION *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
R44	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R45	000272	RES	CARBON	2.7 K		5% 1/4W	81349	RC07GF272J
R46	000272	RES	CARBON	2.7 K		5% 1/4W	81349	RC07GF272J
R47	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R48	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R49	000332	RES	CARBON	3.3 K		5% 1/4W	81349	RC07GF332J
R50	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R51	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R52	000122	RES	CARBON	1.2 K		5% 1/4W	81349	RC07GF122J
R53	000122	RES	CARBON	1.2 K		5% 1/4W	81349	RC07GF122J
R54	000183	RES	CARBON	18 K		5% 1/4W	81349	RC07GF183J
R55	000202	RES	CARBON	2 K		5% 1/4W	81349	RC07GF202J
R56	001738	RES	CARBON	1.5 OHM		5% 1/2W	81349	RC20GF010J
R57	020576	RES	WW	.24 OHM		5% 2 W	07716	BWH Series
R58	000183	RES	CARBON	18 K		5% 1/4W	81349	RC07GF183J
R59	001738	RES	CARBON	1.5 OHM		5% 1/2W	81349	RC20GF010J
R60	040235	POT	CERMET	100 K	89PR100K		73138	89PR100K
R61	010778	RES	METAL	2.74 K		1%	81349	RN55C
R62	010778	RES	METAL	2.74 K		1%	81349	RN55C
R63	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R64	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R69	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R72	040235	POT	CERMET	100 K	89PR100K		73138	89PR100K
R75	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R78	000202	RES	CARBON	2 K		5% 1/4W	81349	RC07GF202J
R79	000510	RES	CARBON	51 OHM		5% 1/4W	81349	RC07GF510J
R80	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R82	000154	RES	CARBON	150 K		5% 1/4W	81349	RC07GF154J
R83	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R84	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R85	000202	RES	CARBON	2 K		5% 1/4W	81349	RC07GF202J
R86	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R89	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R90	000332	RES	CARBON	3.3 K		5% 1/4W	81349	RC07GF332J
R91	000224	RES	CARBON	220 K		5% 1/4W	81349	RC07GF224J
R92	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R93	000822	RES	CARBON	8.2 K		5% 1/4W	81349	RC07GF822J
R94	000432	RES	CARBON	4.3 K		5% 1/4W	81349	RC07GF432J
R95	000822	RES	CARBON	8.2 K		5% 1/4W	81349	RC07GF822J
R96	000432	RES	CARBON	4.3 K		5% 1/4W	81349	RC07GF432J
R97	000822	RES	CARBON	8.2 K		5% 1/4W	81349	RC07GF822J
R103	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J

403614 – Assy., PCB, LOGIC & INTERCONNECTION *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R104	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R105	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R106	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R107	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R108	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R109	000562	RES CARBON 5.6 K 5% 1/4W	81349	RC07GF562J
R110	000562	RES CARBON 5.6 K 5% 1/4W	81349	RC07GF562J
R111	000562	RES CARBON 5.6 K 5% 1/4W	81349	RC07GF562J
R112	000562	RES CARBON 5.6 K 5% 1/4W	81349	RC07GF562J
S2	600683	SWITCH PUSHBUTTON 600683	21793	600683
S3	600683	SWITCH PUSHBUTTON 600683	21793	600683
S4	600683	SWITCH PUSHBUTTON 600683	21793	600683
S5	600683	SWITCH PUSHBUTTON 600683	21793	600683
T2	403553	TRANSFORMER PULSE 403553	21793	403553
T3	403553	TRANSFORMER PULSE 403553	21793	403553
T4	403553	TRANSFORMER PULSE 403553	21793	403553
TP1	600591	POST TEST POINT 85931-6	89110	85931-6
TP2	600591	POST TEST POINT 85931-6	89110	85931-6
TP3	600591	POST TEST POINT 85931-6	89110	85931-6
TP4	600591	POST TEST POINT 85931-6	89110	85931-6
TP5	600591	POST TEST POINT 85931-6	89110	85931-6
TP6	600591	POST TEST POINT 85931-6	89110	85931-6
TP7	600591	POST TEST POINT 85931-6	89110	85931-6
TP8	600591	POST TEST POINT 85931-6	89110	85931-6
TP9	600591	POST TEST POINT 85931-6	89110	85931-6
TP10	600591	POST TEST POINT 85931-6	89110	85931-6
TP11	600591	POST TEST POINT 85931-6	89110	85931-6
TP12	600591	POST TEST POINT 85931-6	89110	85931-6
TP13	600591	POST TEST POINT 85931-6	89110	85931-6
TP14	600591	POST TEST POINT 85931-6	89110	85931-6
U1	230132	INTEGRATED CIRCUIT SN7447N	01295	SN7447N
U2	230132	INTEGRATED CIRCUIT SN7447N	01295	SN7447N
U3	230132	INTEGRATED CIRCUIT SN7447N	01295	SN7447N
U4	230132	INTEGRATED CIRCUIT SN7447N	01295	SN7447N
U5	230132	INTEGRATED CIRCUIT SN7447N	01295	SN7447N
U6	230132	INTEGRATED CIRCUIT SN7447N	01295	SN7447N
U7	230065	INTEGRATED CIRCUIT SN7475N	01295	SN7475N
U8	230065	INTEGRATED CIRCUIT SN7475N	01295	SN7475N

403614 – Assy., PCB, LOGIC & INTERCONNECTION *continued*

REF DES	DANA P/N	DESCRIPTION		FSC	MANU P/N
U9	230065	INTEGRATED CIRCUIT	SN7475N	01295	SN7475N
U10	230065	INTEGRATED CIRCUIT	SN7475N	01295	SN7475N
U11	230065	INTEGRATED CIRCUIT	SN7475N	01295	SN7475N
U12	230028	INTEGRATED CIRCUIT	SN7400N	01295	SN7400N
U13	230064	INTEGRATED CIRCUIT	SN7404N	01295	SN7404N
U14	230037	INTEGRATED CIRCUIT	SN7490N	01295	SN7490N
U15	230037	INTEGRATED CIRCUIT	SN7490N	01295	SN7490N
U16	230037	INTEGRATED CIRCUIT	SN7490N	01295	SN7490N
U17	230037	INTEGRATED CIRCUIT	SN7490N	01295	SN7490N
U18	230037	INTEGRATED CIRCUIT	SN7490N	01295	SN7490N
U19	230114	INTEGRATED CIRCUIT	SN7408N	01295	SN7408N
U20	230114	INTEGRATED CIRCUIT	SN7408N	01295	SN7408N
U21	230114	INTEGRATED CIRCUIT	SN7408N	01295	SN7408N
U22	230064	INTEGRATED CIRCUIT	SN7408N	01295	SN7408N
U23	230064	INTEGRATED CIRCUIT	SN7408N	01295	SN7408N
U24	230064	INTEGRATED CIRCUIT	SN7408N	01295	SN7408N
U25	230064	INTEGRATED CIRCUIT	SN7408N	01295	SN7408N
U26	230072	INTEGRATED CIRCUIT	SN7474N	01295	SN7474N
U27	230072	INTEGRATED CIRCUIT	SN7474N	01295	SN7474N
U28	230029	INTEGRATED CIRCUIT	SN7401N	01295	SN7401N
U29	230072	INTEGRATED CIRCUIT	SN7474N	01295	SN7474N
U30	230030	INTEGRATED CIRCUIT	SN7402N	01295	SN7402N
U31	230028	INTEGRATED CIRCUIT	SN7400N	01295	SN7400N
U32	230031	INTEGRATED CIRCUIT	SN7410N	01295	SN7410N
U33	230035	INTEGRATED CIRCUIT	SN7473N	01295	SN7473N
U34	230028	INTEGRATED CIRCUIT	SN7400N	01295	SN7400N
U35	230064	INTEGRATED CIRCUIT	SN7404N	01295	SN7404N
U36	230116	INTEGRATED CIRCUIT	SN7432N	01295	SN7432N
U37	230080	INTEGRATED CIRCUIT	SN7496N	01295	SN7496N
U38	230028	INTEGRATED CIRCUIT	SN7400N	01295	SN7400N
U39	230037	INTEGRATED CIRCUIT	SN7490N	01295	SN7490N
U40	230028	INTEGRATED CIRCUIT	SN7400N	01295	SN7400N
U41	230071	INTEGRATED CIRCUIT	SN7445N	01295	SN7445N
U42	230073	INTEGRATED CIRCUIT	SN7405N	01295	SN7405N
U43	230029	INTEGRATED CIRCUIT	SN7401N	01295	SN7401N
U44	230133	INTEGRATED CIRCUIT	SN74121	01295	SN74121
W2	600245	JUMPER	L-2007-1		L-2007-1
W3	600245	JUMPER	L-2007-1		L-2007-1
Y1	920627	CRYSTAL	6 MHz	13571	6 MHz

403647 – Assy., PCB, READOUT (Figure 6.3)

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
LED1	210052	L.E.D. DISPLAY MAN64A	50522	MAN64A
LED2	210052	L.E.D. DISPLAY MAN64A	50522	MAN64A
LED3	210052	L.E.D. DISPLAY MAN64A	50522	MAN64A
LED4	210052	L.E.D. DISPLAY MAN64A	50522	MAN64A
LED5	210052	L.E.D. DISPLAY MAN64A	50522	MAN64A
LED6	210052	L.E.D. DISPLAY MAN64A	50522	MAN64A
R1	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R2	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R3	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R4	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R5	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R6	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R7	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R8	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R9	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R10	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R11	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R12	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R13	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R14	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R15	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R16	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R17	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R18	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R19	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R20	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R21	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R22	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R23	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R24	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R25	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R26	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R27	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R28	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R29	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R30	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R31	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R32	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R33	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R34	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R35	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J

403647 – Assy., PCB, READOUT *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R36	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R37	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R38	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R39	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R40	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R41	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R42	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R43	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R44	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R45	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R46	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J

403623 – Assy., PCB, ATTENUATOR (Figure 6.5)

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
C1	100022	CAP	CERAM	.002 MFD	1000 V	10%	71471	GPDX5F202K
C2	100012	CAP	CERAM	33 PFD		10%	71471	TCD-DI-1(N750)
C3	120309	CAP	POLY	.015 MFD	200 V		27556	PA2C153J
C4	120313	CAP	POLY	.15 MFD	200 V		27556	PA2C154J
CR1	211083	DIODE	SILICO		018		21793	211083
CR2	211083	DIODE	SILICO		018		21793	211083
CR3	211083	DIODE	SILICO		018		21793	211083
CR4	211083	DIODE	SILICO		018		21793	211083
CR5	211083	DIODE	SILICO		018		21793	211083
CR6	211083	DIODE	SILICO		018		21793	211083
CR7	211083	DIODE	SILICO		018		21793	211083
CR8	211083	DIODE	SILICO		018		21793	211083
K1	310111	RELAY			28 V		77342	R10-E-2314-1
K2	310112	RELAY			28 V		77342	R10-E-2315-1
K3	310111	RELAY			28 V		77342	R10-E-2314-1
K4	310113	RELAY	REED	SHIELD	R4092-3		15636	R4092-3
R1	000107	RES	CARBON	100 M		5% 1/4W	81349	RC07GF107J
R2	001796	RES	CARBON	2.7 OHM		5% 1/4W		
R3	010027	RES	METAL	499 OHM	T-0	1%	81349	RN60D4990F
R4	010769	RES	METAL	4.5 K		.01%	18612	HP202
R5	040229	POT	CERMET	1 K		10%	73138	89P Series
R6	010770	RES	METAL	45.0097 K		.01%	18612	HP202
R7	000392	RES	CARBON	3.9 K		5% 1/4W	81349	RC07GF392J
R8	001806	RES	CARBON	200 K		5% 2 W		
R9	001806	RES	CARBON	200 K		5% 2 W		
R11	040229	POT	CERMET	1 K		10%	73138	89P Series
R12	020640	RES	WW	899.45 K	SET		21793	020640
R13	040229	POT	CERMET	1 K		10%	73138	89P Series
R14	010161	RES	METAL	110 OHM	T-0	1%	81349	RN60D1100F
R15	020640	RES	WW	99.950 K	SET		21793	020640
R16	010768	RES	METAL	500 OHM		.01%	18612	HP202-M
R17	000107	RES	CARBON	100 M		5% 1/4W	81349	RC07GF107J
R18	040235	POT	CERMET	100 K	89PR100K		73138	89PR100K
R19	010033	RES	METAL	49.9 K		1%	81349	RN60D4992F
R20	000107	RES	CARBON	100 M		5% 1/4W	81349	RC07GF107J
R21	010616	RES	METAL	50 K		.1%	81349	RN55C
R22	010616	RES	METAL	50 K		.1%	81349	RN55C
R23	010616	RES	METAL	50 K		.1%	81349	RN55C
R24	020640	RES	WW	2.2499 M	SET		21793	020640

403623 – Assy., PCB, ATTENUATOR *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R25	020640	RES WW 2.2499 M SET	21793	020640
R26	020640	RES WW 2.2499 M SET	21793	020640
R27	020640	RES WW 2.2499 M SET	21793	020640
AR1	230103	INTEGRATED CIRCUIT AMP LM308	27014	LM308

403625 – Assy., PCB, SWITCHING (Figure 6.7)

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
CR1	211083	DIODE SILICO 018	21793	211083
CR2	211083	DIODE SILICO 018	21793	211083
CR3	220019	DIODE SILICO ZENER 1N752A	81349	1N752A
CR4	220022	DIODE SILICO ZENER 1N965B	81349	1N965B
CR5	211083	DIODE SILICO 018	21793	211083
CR6	211083	DIODE SILICO 018	21793	211083
CR7	211083	DIODE SILICO 018	21793	211083
CR8	211083	DIODE SILICO 018	21793	211083
K1	310110	RELAY 5 V	77342	R10-E2445-1
K2	310110	RELAY 5 V	77342	R10-E2445-1
OCI-1	250000	ISOLATOR OPTICALLY COUPLED	01295	TIL108
OCI-2	250000	ISOLATOR OPTICALLY COUPLED	01295	TIL108
OCI-3	250000	ISOLATOR OPTICALLY COUPLED	01295	TIL108
Q1	200200	TRANS NPN SKA8085	01295	SKA8085
Q2	200200	TRANS NPN SKA8085	01295	SKA8085
Q3	200200	TRANS NPN SKA8085	01295	SKA8085
Q4	200200	TRANS NPN SKA8085	01295	SKA8085
Q5	200200	TRANS NPN SKA8085	01295	SKA8085
Q6	200200	TRANS NPN SKA8085	01295	SKA8085
Q7	200200	TRANS NPN SKA8085	01295	SKA8085
Q8	200200	TRANS NPN SKA8085	01295	SKA8085
Q9	200200	TRANS NPN SKA8085	01295	SKA8085
R1	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R2	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R3	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R4	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R5	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R6	000361	RES CARBON 360 OHM 5% 1/4W	81349	RC07GF361J
R7	000361	RES CARBON 360 OHM 5% 1/4W	81349	RC07GF361J
R8	000361	RES CARBON 360 OHM 5% 1/4W	81349	RC07GF361J
R9	000203	RES CARBON 20 K 5% 1/4W	81349	RC07GF203J
R10	000203	RES CARBON 20 K 5% 1/4W	81349	RC07GF203J
R11	000203	RES CARBON 20 K 5% 1/4W	81349	RC07GF203J
R12	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R13	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R14	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R15	000682	RES CARBON 6.8 K 5% 1/4W	81349	RC07GF682J
R16	000472	RES CARBON 4.7 K 5% 1/4W	81349	RC07GF472J

403625 – Assy., PCB, SWITCHING *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R17	000472	RES CARBON 4.7 K 5% 1/4W	81349	RC07GF472J
R18	000472	RES CARBON 4.7 K 5% 1/4W	81349	RC07GF472J
U1	230073	INTEGRATED CIRCUIT SN7405N	01295	SN7405N
U2	230034	INTEGRATED CIRCUIT SN7441N	01295	SN7441N

403624 – Assy., PCB, ISOLATOR (Figure 6.9)

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
C1	120004	CAP	POLY	.001 MFD	630 V	5%	08257	KSO Series
C2	101175	CAP	CERAM	220 PFD	100 V	10%	71471	SCD1X5F
C3	101175	CAP	CERAM	220 PFD	100 V	10%	71471	SCD1X5F
C4	101145	CAP	CERAM	100 PFD		10%	71471	ETCD-DI-1(N5600)
C5	101099	CAP	CERAM	680 PFD		10%	71471	SCD2X5F
C6	121092	CAP	MYLAR	.0022 MFD	100 V	10%	09023	WMF1D22
C7	101145	CAP	CERAM	100 PFD		10%	71471	ETCD-DI-1(N5600)
C8	100012	CAP	CERAM	33 PFD		10%	71471	TCD-DI-1(N750)
C9	120271	CAP	POLY	.5 MFD	50 V	5%	27556	PV2A504J
C10	101182	CAP	CERAM	47 PFD		10%	71471	TCD-DI-2(N750)
C11	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C12	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C13	101182	CAP	CERAM	47 PFD		10%	71471	TCD-DI-2(N750)
C14	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C16	120313	CAP	POLY	.15 MFD	200 V		27556	PA2C154J
C17	101174	CAP	CERAM	.001 MFD	500 V	10%	71471	SCD3X5F
C18	121394	CAP	MYLAR	.15 MFD	100 V	10%	09023	WMF1P15
C19	101145	CAP	CERAM	100 PFD		10%	71471	ETCD-DI-1(N5600)
C20	120313	CAP	POLY	.15 MFD	200 V		27556	PA2C154J
C21	110163	CAP	TANTA	4.7 MFD	35 V	20%	05397	E Series
C22	110163	CAP	TANTA	4.7 MFD	35 V	20%	05397	E Series
C23	101145	CAP	CERAM	100 PFD		10%	71471	ETCD-DI-1(N5600)
C24	101145	CAP	CERAM	100 PFD		10%	71471	ETCD-DI-1(N5600)
C25	100012	CAP	CERAM	33 PFD		10%	71471	TCD-DI-1(N750)
C26	100012	CAP	CERAM	33 PFD		10%	71471	TCD-DI-1(N750)
C27	100012	CAP	CERAM	33 PFD		10%	71471	TCD-DI-1(N750)
CR1	211083	DIODE	SILICO		018		21793	211083
CR2	220015	DIODE	SILICO	ZENER	1N967B		81349	1N967B
CR3	220035	DIODE		ZENER	1N966B		81349	1N966B
CR4	220007	DIODE	SILICO	ZENER	1N751A		81349	1N751A
CR5	220007	DIODE	SILICO	ZENER	1N751A		81349	1N751A
CR6	210004	DIODE	SILICO		SD4		12060	SD4
CR7	210004	DIODE	SILICO		SD4		12060	SD4
CR8	211083	DIODE	SILICO		018		21793	211083
CR9	211083	DIODE	SILICO		018		21793	211083
CR10	211083	DIODE	SILICO		018		21793	211083
CR11	211083	DIODE	SILICO		018		21793	211083
CR12	211083	DIODE	SILICO		018		21793	211083
K1A	310113	RELAY	REED	SHIELD	R4092-3		15636	R4092-3
K1B	310113	RELAY	REED	SHIELD	R4092-3		15636	R4092-3
Q1	200191	TRANS		PNP	2N1305		81349	2N1305

403624 – Assy., PCB, ISOLATOR *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
Q2	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q3	200088	TRANS	SILICO	PNP	2N4248		80131	2N4248
Q4	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q5	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q6	200201	TRANS	DUAL	NPN	MPS301			MPS301
Q7	200199	TRANS	DUAL	FET	FM1302		27014	FM1302
Q8	200088	TRANS	SILICO	PNP	2N4248		80131	2N4248
Q9	200200	TRANS		NPN	SKA8085		01295	SKA8085
R1	010529	RES	METAL	10 K	T-0	1%	81349	RN55D
R2	010277	RES	METAL	442 OHM	T-0	1% 1/4W	81349	RN55C4420F
R3	040235	POT	CERMET	100 K	89PR100K		73138	89PR100K
R4	001810	RES	CARBON	47 M		5% 1/2W		
R5	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R6	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R7	040235	POT	CERMET	100 K	89PR100K		73138	89PR100K
R8	001810	RES	CARBON	47 M		5% 1/2W		
R9	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R10	001737	RES	CARBON	FSV		5% 1/4W	21793	001737
R11	010779	RES	METAL	806 K		1%	81349	RN65E
R12	001737	RES	CARBON	FSV		5% 1/4W	21793	001737
R13	000220	RES	CARBON	2.2 OHM		5% 1/4W	81349	RC07GF220J
R14	040232	POT	CERMET	10 K	89PR10K		73138	89PR10K
R15	010429	RES	METAL	475 K		1%	81349	RN60D4753F
R16	001737	RES	CARBON	FSV		5% 1/4W	21793	001737
R17	010779	RES	METAL	806 K		1%	81349	RN65E
R18	001737	RES	CARBON	FSV		5% 1/4W	21793	001737
R19	000432	RES	CARBON	4.3 K		5% 1/4W	81349	RC07GF432J
R20	000432	RES	CARBON	4.3 K		5% 1/4W	81349	RC07GF432J
R21	000513	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF513J
R22	000513	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF513J
R24	010106	RES	METAL	324 K	T-0	1%	81349	RN60D
R25	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R26	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R28	010106	RES	METAL	324 K	T-0	1%	81349	RN60D
R29	010536	RES	METAL	100 K	T-0	1%	81349	RN55D1003F
R30	010529	RES	METAL	10 K		1%	81349	RN55D
R31	010536	RES	METAL	100 K	T-0	1%	81349	RN55D1003F
R32	010621	RES	METAL	49.9 K		1%	81349	RN55C4992F
R33	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R34	000241	RES	CARBON	240 OHM		5% 1/4W	81349	RC07GF241J

403624 – Assy., PCB, ISOLATOR *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R36	000104	RES CARBON 100 K 5% 1/4W	81349	RC07GF104J
R37	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
AR1	230103	INTEGRATED CIRCUIT LM308	27014	LM308
AR2	230054	INTEGRATED CIRCUIT LM301A	27014	LM301A
AR3	230054	INTEGRATED CIRCUIT LM301A	27014	LM301A
AR4	230054	INTEGRATED CIRCUIT LM301A	27014	LM301A
AR5	230054	INTEGRATED CIRCUIT LM301A	27014	LM301A
TP1	600591	POST TEST POINT 85931-6	89110	85931-6
TP2	600591	POST TEST POINT 85931-6	89110	85931-6
TP3	600591	POST TEST POINT 85931-6	89110	85931-6

403658 – Assy., PCB, 10V REFERENCE (Figure 6.12)

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
CR1*	220032	DIODE	ZENER		403686		21793	403686
Q1	200196	TRANS		NPN	2N3568		81349	2N3568
R1*	020654	RES	WW			1%	22045	J-90
R2	020641	RES	WW	10 K		1% .05 W	22045	J-90
R3	040232	POT		10 K	89PR10K		73138	89PR10K
R4	040235	POT	CERMET	100 K	89PR100K		73138	89PR100K
R5	040235	POT	CERMET	100 K	89PR100K		73138	89PR100K
R6	000565	RES	CARBON	5.6 M		5% 1/4W	81349	RC07GF565J
R7	010774	RES	METAL	3.7 K		.01%	18612	V53-1
R8	010773	RES	METAL	6.3 K		.01%	18612	V53-1
R9*	403686	RES	SET	FSV	403686		21793	403686
R10*	403686	RES	SET	FSV	403686		21793	403686
AR1	230070	INTEGRATED CIRCUIT			μA725		07263	U5B7725393

*Zener Ref FSV Kit 403686
All other components are Ref Amp Assy 403726

403626 – Assy., PCB, DIGITIZER (Figure 6.12)

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
C1	110125	CAP	TANTA	2.2 MFD	35 V		71468	4321217122
C2	110125	CAP	TANTA	2.2 MFD	35 V		71468	4321217122
C3	101098	CAP	CERAM	330 PFD		10%	56289	C016B102E331K
C4	101642	CAP	CERAM	150 PFD		10%	71471	SCD1X5F
C5	101174	CAP	CERAM	.001 MFD	500 V	10%	71471	SCD3X5F
C6	100006	CAP	CERAM	10 PFD	TCDI-1(N750)		71471	TCDI-1(N750)
C7	110127	CAP	TANTA	22 MFD	6.3 V		71468	4321212222
C8	120253	CAP		.33 MFD	100 V	5%	71785	863UW
C9	101642	CAP	CERAM	150 PFD		10%	71471	SCD1X5F
C10	110125	CAP	TANTA	2.2 MFD	35 V		71468	4321217122
C11	101642	CAP	CERAM	150 PFD		10%	71471	SCD1X5F
C12	100012	CAP	CERAM	33 PFD		10%	71471	TCD-DI-1(N750)
C13	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C15	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C16	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C17	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C18	100068	CAP	CERAM	.02 MFD	100 V	20%	56289	TG-S20
C19	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C20	100068	CAP	CERAM	.02 MFD	100 V	20%	56289	TG-S20
C21	120308	CAP		.047 MFD	250 V	10%	73445	C280MAE/A47K
C26	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C27	130142	CAP		150 PFD	50 V	5%	72136	DM5-151J
C28	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C29	120308	CAP		.047 MFD	250 V	10%	73445	C280MAE/A47K
C30	100068	CAP	CERAM	.02 MFD	100 V	20%	56289	TG-S20
C31	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C32	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C36	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C37	110127	CAP	TANTA	22 MFD	6.3 V		71468	4321212222
C38	110129	CAP	TANTA	.1 MFD	35 V		71468	4321217010
C39	101098	CAP	CERAM	330 PFD		10%	56289	C016B102E331K
C41	100006	CAP	CERAM	10 PFD	TCDI-1(N750)		71471	TCDI-1(N750)
C42	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C43	110165	CAP	TANTA	.15 MFD	35 V	10%	05397	T360A154035AS
CR1	220054	DIODE		ZENER	1N5260B		81349	1N5260B
CR2	220059	DIODE		ZENER	33 V	5%	81349	1N973B
CR3	211083	DIODE	SILICO		018		21793	211083
CR4	211083	DIODE	SILICO		018		21793	211083
CR5	211083	DIODE	SILICO		018		21793	211083
CR6	211083	DIODE	SILICO		018		21793	211083
CR7	211083	DIODE	SILICO		018		21793	211083
CR8	211083	DIODE	SILICO		018		21793	211083

403626 – Assy., PCB, DIGITIZER *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
CR9	211083	DIODE SILICO 018	21793	211083
CR10	211083	DIODE SILICO 018	21793	211083
CR11	211083	DIODE SILICO 018	21793	211083
CR12	211083	DIODE SILICO 018	21793	211083
CR13	211083	DIODE SILICO 018	21793	211083
CR14	220022	DIODE SILICO ZENER 1N965B	81349	1N965B
CR15	220007	DIODE SILICO ZENER 1N751A	81349	1N751A
CR16	211083	DIODE SILICO 018	21793	211083
CR17	211083	DIODE SILICO 018	21793	211083
CR18	220007	DIODE SILICO ZENER 1N751A	81349	1N751A
CR19	220007	DIODE SILICO ZENER 1N751A	81349	1N751A
CR20	211083	DIODE SILICO 018	21793	211083
CR21	211083	DIODE SILICO 018	21793	211083
CR22	220022	DIODE SILICO ZENER 1N965B	81349	1N965B
CR25	220022	DIODE SILICO ZENER 1N965B	81349	1N965B
CR26	220031	DIODE SILICO ZENER 1/4M3.3AZ5	04713	1/4M3.3AZ5
CR27	211083	DIODE SILICO 018	21793	211083
CR28	211083	DIODE SILICO 018	21793	211083
CR29	220031	DIODE SILICO ZENER 1/4M3.3AZ5	04713	1/4M3.3AZ5
CR31	221177	DIODE SILICO ZENER 1/4M2.4AZ5	04713	1/4M2.4AZ5
Q1	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q2	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q3	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q4	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q5	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q6	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q7	200088	TRANS SILICO PNP 2N4248	80131	2N4248
Q8	200162	SWITCHES FET MATCHED SET		L1008
Q9	200200	TRANS NPN SKA8085	01295	SKA8085
Q10	200162	SWITCHES FET MATCHED SET		L1008
Q11	200200	TRANS NPN SKA8085	01295	SKA8085
Q12	200162	SWITCHES FET MATCHED SET		L1008
Q13	200200	TRANS NPN SKA8085	01295	SKA8085
Q16	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q17	200161	TRANS DUAL FET E415	17856	E415
Q18	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q19	200160	TRANS FET KE4416		KE4416
Q20	200160	TRANS FET KE4416		KE4416
Q21	200037	TRANS SILICO NPN 2N3646	80131	2N3646
Q22	200200	TRANS NPN SKA8085	01295	SKA8085
Q23	200037	TRANS SILICO NPN 2N3646	80131	2N3646

403626 – Assy., PCB, DIGITIZER *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
Q24	200203	TRANS	FET		E-201		17856	E-201
Q25	200203	TRANS	FET		E-201		17856	E-201
Q26	200088	TRANS	SILICO	PNP	2N4248		80131	2N4248
Q27	200088	TRANS	SILICO	PNP	2N4248		80131	2N4248
Q28	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q29	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q30	200037	TRANS	SILICO	NPN	2N3646		80131	2N3646
Q31	200099	TRANS			2N4258		81349	2N4258
Q32	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q33	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q34	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q35	200088	TRANS	SILICO	PNP	2N4248		80131	2N4248
Q36	200088	TRANS	SILICO	PNP	2N4248		80131	2N4248
Q37	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q38	200068	TRANS			2N4250		80131	2N4250
Q41	200201	TRANS	DUAL	NPN	MPS301			MPS301
Q43	200037	TRANS	SILICO	NPN	2N3646		80131	2N3646
Q44	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q45	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q46	200200	TRANS		NPN	SKA8085		01295	SKA8085
R1	000273	RES	CARBON	27 K		5% 1/4W	81349	RC07GF273J
R2	040240	POT	CERMET	10 OHM	89PR10		73138	89PR10
R3	000101	RES	CARBON	100 OHM		5% 1/4W	81349	RC07GF101J
R4	000101	RES	CARBON	100 OHM		5% 1/4W	81349	RC07GF101J
R5	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R6	000104	RES	CARBON	100 K		5% 1/4W	81349	RC07GF104J
R7	000202	RES	CARBON	2 K		5% 1/4W	81349	RC07GF202J
R8	000104	RES	CARBON	100 K		5% 1/4W	81349	RC07GF104J
R9	000202	RES	CARBON	2 K		5% 1/4W	81349	RC07GF202J
R10	000202	RES	CARBON	2 K		5% 1/4W	81349	RC07GF202J
R11	000302	RES	CARBON	3 K		5% 1/4W	81349	RC07GF302J
R12	000152	RES	CARBON	1.5 K		5% 1/4W	81349	RC07GF152J
R13	000302	RES	CARBON	3 K		5% 1/4W	81349	RC07GF302J
R14	000152	RES	CARBON	1.5 K		5% 1/4W	81349	RC07GF152J
R15	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R16	000104	RES	CARBON	100 K		5% 1/4W	81349	RC07GF104J
R17	000104	RES	CARBON	100 K		5% 1/4W	81349	RC07GF104J
R18	010621	RES	METAL	49.9 K	T-0	1%	81349	RN55C4992F
R19	000152	RES	CARBON	1.5 K		5% 1/4W	81349	RC07GF152J
R20	000153	RES	CARBON	15 K		5% 1/4W	81349	RC07GF153J
R21	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J

403626 – Assy., PCB, DIGITIZER *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
R22	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R23	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R24	000153	RES	CARBON	15 K		5% 1/4W	81349	RC07GF153J
R25	000272	RES	CARBON	2.7 K		5% 1/4W	81349	RC07GF272J
R26	010013	RES	METAL	60.4 K	T-2	1%	81349	RN60C6042F
R27	040228	POT	CERMET	500 OHM		10%	73138	89PR500
R28	010621	RES	METAL	49.9 K	T-0	1%	81349	RN55C4992F
R29	000473	RES	CARBON	47 K		5% 1/4W	81349	RC07GF473J
R30	010013	RES	METAL	60.4 K	T-2	1%	81349	RN60C6042F
R31	010502	RES	METAL	249 K		1%	81349	RN60D2493F
R32	000302	RES	CARBON	3.0 K		5% 1/4W	81349	RC07GF302J
R33	000153	RES	CARBON	15 K		5% 1/4W	81349	RC07GF153J
R34	000104	RES	CARBON	100 K		5% 1/4W	81349	RC07GF104J
R35	010027	RES	METAL	499 OHM	T-0	1%	81349	RN50D4990F
R36	010621	RES	METAL	49.9 K	T-0	1%	81349	RN55C4992F
R37	001737	RES	CARBON	FSV		5% 1/4W	21793	001737
R38	000107	RES	CARBON	100 M		5% 1/4W	81349	RC07GF107J
R39	000476	RES	CARBON	47 M		5% 1/4W	81349	RC07GF476J
R40	040233	POT		20 K	89PR20K		73138	89PR20K
R41	000272	RES	CARBON	2.7 K		5% 1/4W	81349	RC07GF272J
R42	000153	RES	CARBON	15 K		5% 1/4W	81349	RC07GF153J
R43	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R44	000104	RES	CARBON	100 K		5% 1/4W	81349	RC07GF104J
R45	001737	RES	CARBON	FSV		5% 1/4W	21793	001737
R46	000272	RES	CARBON	2.7 K		5% 1/4W	81349	RC07GF272J
R47	000153	RES	CARBON	15 K		5% 1/4W	81349	RC07GF153J
R50	000392	RES	CARBON	3.9 K		5% 1/4W	81349	RC07GF392J
R51	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R52	000204	RES	CARBON	200 K		5% 1/4W	81349	RC07GF204J
R53	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R54	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R55	000392	RES	CARBON	3.9 K		5% 1/4W	81349	RC07GF392J
R56	000152	RES	CARBON	1.5 K		5% 1/4W	81349	RC07GF152J
R57	040235	POT	CERMET	100 K		10%	73138	89PR100K
R58	000390	RES	CARBON	39 OHM		5% 1/4W	81349	RC07GF390J
R59	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R60	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R61	000622	RES	CARBON	6.2 K		5% 1/4W	81349	RC07GF622J
R62	000206	RES	CARBON	20 M		5% 1/4W	81349	RC07GF206J
R63	010871	RES	MATCHED PAIR	5 K	HP202		18612	HP202
R64	040235	POT	CERMET	100 K		10%	73138	89PR100K

403626 – Assy., PCB, DIGITIZER *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
R65	000100	RES	CARBON	10 OHM		5% 1/4W	81349	RC07GF100J
R66	010520	RES	METAL	21.5 K	T-0	1% 1/4W	81349	RN60D
R67	010871	RES	MATCHED PAIR	5 K	HP202		18612	HP202
R68	010646	RES	METAL	2.49 K	T-0	1%	81349	RN55D2491F
R70	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R71	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R72	010124	RES	METAL	19.6 K	T-0	1%	81349	RN60D1962F
R73	000750	RES	CARBON	75 OHM		5% 1/4W	81349	RC07GF750J
R74	010533	RES	METAL	28.7 K		1%	81349	RN55D
R75	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R76	000390	RES	CARBON	39 OHM		5% 1/4W	81349	RC07GF390J
R77	000104	RES	CARBON	100 K		5% 1/4W	81349	RC07GF104J
R78	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R79	000510	RES	CARBON	51 OHM		5% 1/4W	81349	RC07GF510J
R80	000200	RES	CARBON	20 OHM		5% 1/4W	81349	RC07GF200J
R81	000183	RES	CARBON	18 K		5% 1/4W	81349	RC07GF183J
R82	000202	RES	CARBON	2 K		5% 1/4W	81349	RC07GF202J
R83	000104	RES	CARBON	100 K		5% 1/4W	81349	RC07GF104J
R84	000565	RES	CARBON	5.6 M		5% 1/4W	81349	RC07GF565J
R85	000100	RES	CARBON	10 OHM		5% 1/4W	81349	RC07GF100J
R86	001737	RES	CARBON	FSV		5% 1/4W	21793	001737
R87	001737	RES	CARBON	FSV		5% 1/4W	21793	001737
R88	000204	RES	CARBON	200 K		5% 1/4W	81349	RC07GF204J
T1	403553	TRANSFORMER		PULSE	403553		21793	403553
T2	403553	TRANSFORMER		PULSE	403553		21793	403553
T3	403553	TRANSFORMER		PULSE	403553		21793	403553
TP1	600591	POST	TEST POINT		85931-6		89110	85931-6
TP2	600591	POST	TEST POINT		85931-6		89110	85931-6
TP3	600591	POST	TEST POINT		85931-6		89110	85931-6
TP4	600591	POST	TEST POINT		85931-6		89110	85931-6
TP5	600591	POST	TEST POINT		85931-6		89110	85931-6
TP6	600591	POST	TEST POINT		85931-6		89110	85931-6
TP7	600591	POST	TEST POINT		85931-6		89110	85931-6
TP8	600591	POST	TEST POINT		85931-6		89110	85931-6
TP9	600591	POST	TEST POINT		85931-6		89110	85931-6
TP10	600591	POST	TEST POINT		85931-6		89110	85931-6
TP11	600591	POST	TEST POINT		85931-6		89110	85931-6
TP12	600591	POST	TEST POINT		85931-6		89110	85931-6

403626 – Assy., PCB, DIGITIZER *continued*

REF DES	DANA P/N	DESCRIPTION		FSC	MANU P/N
AR1	230054	INTEGRATED CIRCUIT	LM301A	27014	LM301A
AR2	230090	INTEGRATED CIRCUIT	SL22348	07263	SL22348
U1	230076	INTEGRATED CIRCUIT	SN74L00N	01295	SN74L00N
U2	230076	INTEGRATED CIRCUIT	SN74L00N	01295	SN74L00N

403616 – Assy., PCB, PROGRAM (Figure 6.14)

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
C1	110152	CAP	TANTA	.47 MFD	50 V	10%	05397	T368A474K050
C2	110165	CAP	TANTA	.15 MFD	35 V	10%	05397	T360A154035AS
C3	110153	CAP	TANTA	.27 MFD	50 V	10%	05397	KR27P50K
C4	121091	CAP	MYLAR	.033 MFD	100 V	10%	09023	WMF1S33
C5	120308	CAP		.047 MFD	250 V	10%	73445	C280MAE/A47K
C6	120308	CAP		.047 MFD	250 V	10%	73445	C280MAE/A47K
CR1	211083	DIODE	SILICO		018		21793	211083
CR2	211083	DIODE	SILICO		018		21793	211083
CR3	211083	DIODE	SILICO		018		21793	211083
Q1	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q2	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q3	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q4	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q5	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q6	200136	TRANS			2N5963		81349	2N5963
Q7	200088	TRANS	SILICO	PNP	2N4248		80131	2N4248
Q8	200037	TRANS	SILICO	NPN	2N3646		80131	2N3646
Q9	200037	TRANS	SILICO	NPN	2N3646		80131	2N3646
Q10	200037	TRANS	SILICO	NPN	2N3646		80131	2N3646
R1	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R2	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R3	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R4	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R5	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R6	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R7	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R8	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R9	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R10	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R11	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R12	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R13	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R14	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R15	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R16	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R17	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R18	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R19	000432	RES	CARBON	4.3 K		5% 1/4W	81349	RC07GF432J
R20	000432	RES	CARBON	4.3 K		5% 1/4W	81349	RC07GF432J
R21	000432	RES	CARBON	4.3 K		5% 1/4W	81349	RC07GF432J
R22	000432	RES	CARBON	4.3 K		5% 1/4W	81349	RC07GF432J

403616 – Assy., PCB, PROGRAM *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
R23	010650	RES	METAL	1 M		1%	81349	RN55E
R24	000105	RES	CARBON	1 M		5% 1/4W	81349	RC07GF105J
R25	010529	RES	METAL	10 K	T-0	1%	81349	RN55D
R26	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R27	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R28	010676	RES	METAL	15 K		1%	81349	RN55C1502F
R29	000242	RES	CARBON	2.4 K		5% 1/4W	81349	RC07GF242J
R30	010697	RES	METAL	26.7 K		1%	81349	RN55D
R31	000222	RES	CARBON	2.2 K		5% 1/4W	81349	RC07GF222J
R32	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R33	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R34	000242	RES	CARBON	2.4 K		5% 1/4W	81349	RC07GF242J
R35	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R36	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R37	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R38	000222	RES	CARBON	2.2 K		5% 1/4W	81349	RC07GF222J
R39	000222	RES	CARBON	2.2 K		5% 1/4W	81349	RC07GF222J
U1	230029	INTEGRATED CIRCUIT			SN7401N		01295	SN7401N
U2	230114	INTEGRATED CIRCUIT			SN7408N		01295	SN7408N
U3	230029	INTEGRATED CIRCUIT			SN7401N		01295	SN7401N
U4	230029	INTEGRATED CIRCUIT			SN7401N		01295	SN7401N
U5	230028	INTEGRATED CIRCUIT			SN7400N		01295	SN7400N
U6	230065	INTEGRATED CIRCUIT			SN7475N		01295	SN7475N
U7	230065	INTEGRATED CIRCUIT			SN7475N		01295	SN7475N
U8	230065	INTEGRATED CIRCUIT			SN7475N		01295	SN7475N
U9	230029	INTEGRATED CIRCUIT			SN7401N		01295	SN7401N
U10	230029	INTEGRATED CIRCUIT			SN7401N		01295	SN7401N
U11	230115	INTEGRATED CIRCUIT			SN7409N		01295	SN7409N
U12	230029	INTEGRATED CIRCUIT			SN7401N		01295	SN7401N
U13	230028	INTEGRATED CIRCUIT			SN7400N		01295	SN7400N

403615 – Assy., PCB, DISPLAY (Figure 6.16)

REF DES	DANA P/N	DESCRIPTION				FSC	MANU P/N
CR1	220031	DIODE	SILICO	ZENER	1/4M3.3AZ5	04713	1/4M3.3AZ5
Q1	200087	TRANS			021	21793	200087
Q2	200087	TRANS			021	21793	200087
Q3	200087	TRANS			021	21793	200087
Q4	200087	TRANS			021	21793	200087
Q5	200087	TRANS			021	21793	200087
Q6	200087	TRANS			021	21793	200087
Q7	200087	TRANS			021	21793	200087
Q8	200087	TRANS			021	21793	200087
Q9	200087	TRANS			021	21793	200087
Q10	200087	TRANS			021	21793	200087
Q11	200087	TRANS			021	21793	200087
R1	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R2	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R3	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R4	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R5	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R6	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R7	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R8	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R9	000272	RES	CARBON	2.7 K	5% 1/4W	81349	RC07GF272J
R10	000272	RES	CARBON	2.7 K	5% 1/4W	81349	RC07GF272J
R11	000272	RES	CARBON	2.7 K	5% 1/4W	81349	RC07GF272J
R12	000272	RES	CARBON	2.7 K	5% 1/4W	81349	RC07GF272J
R13	000272	RES	CARBON	2.7 K	5% 1/4W	81349	RC07GF272J
R14	000272	RES	CARBON	2.7 K	5% 1/4W	81349	RC07GF272J
R15	000272	RES	CARBON	2.7 K	5% 1/4W	81349	RC07GF272J
R16	000272	RES	CARBON	2.7 K	5% 1/4W	81349	RC07GF272J
R17	000132	RES	CARBON	1.3 K	5% 1/4W	81349	RC07GF132J
R18	000102	RES	CARBON	1 K	5% 1/4W	81349	RC07GF102J
R19	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R20	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R21	000132	RES	CARBON	1.3 K	5% 1/4W	81349	RC07GF132J
R22	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R23	000132	RES	CARBON	1.3 K	5% 1/4W	81349	RC07GF132J
R24	000102	RES	CARBON	1 K	5% 1/4W	81349	RC07GF102J
R25	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R26	000512	RES	CARBON	5.1 K	5% 1/4W	81349	RC07GF512J
R27	000102	RES	CARBON	1 K	5% 1/4W	81349	RC07GF102J
R28	000272	RES	CARBON	2.7 K	5% 1/4W	81349	RC07GF272J

403615 – Assy., PCB, DISPLAY *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R29	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R30	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R31	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R32	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R33	000331	RES CARBON 330 OHM 5% 1/4W	81349	RC07GF331J
S1	600675	SWITCH ROTARY 600675	21793	600675
S2	600674	SWITCH ROTARY 600674	21793	600674
U1	230115	INTEGRATED CIRCUIT SN7409N	01295	SN7409N
U2	230115	INTEGRATED CIRCUIT SN7409N	01295	SN7409N
U3	230064	INTEGRATED CIRCUIT SN7404N	01295	SN7404N
U4	230067	INTEGRATED CIRCUIT SN74192	01295	SN74192
U5	230074	INTEGRATED CIRCUIT SN7442N	07716	SN7442N
U6	230114	INTEGRATED CIRCUIT SN7408N	01295	SN7408N
U7	230073	INTEGRATED CIRCUIT SN7405N	01295	SN7405N
U8	230028	INTEGRATED CIRCUIT SN7400N	01295	SN7400N
U9	230030	INTEGRATED CIRCUIT SN7402N	01295	SN7402N
U10	230030	INTEGRATED CIRCUIT SN7402N	01295	SN7402N
U11	230030	INTEGRATED CIRCUIT SN7402N	01295	SN7402N
U12	230116	INTEGRATED CIRCUIT SN7432N	01295	SN7432N
U13	230115	INTEGRATED CIRCUIT SN7409N	01295	SN7409N
U14	230031	INTEGRATED CIRCUIT SN7410N	01295	SN7410N
U15	230029	INTEGRATED CIRCUIT SN7401N	01295	SN7401N
U16	230073	INTEGRATED CIRCUIT SN7405N	01295	SN7405N

403667 – Assy., PCB, AC CONVERTER (Figure 6.19)

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
B1	920563	BEAD	SHIELDING		56-59065-4B		02114	56-59065-4B
B2	920563	BEAD	SHIELDING		56-59065-4B		02114	56-59065-4B
C2	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C3	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C4	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C5	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C6	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C7	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C8	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C9	100012	CAP	CERAM	33 PFD	500 V	10%	71471	TCD-DI-1(N750)
C10	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C11	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C12	100095	CAP	CERAM	2.7 PFD	500 V		56289	10TCCV27
C13	130131	CAP		20 PFD	100 V		73445	C010KA/20E
C14	100095	CAP	CERAM	2.7 PFD	500 V		56289	10TCCV27
C15	121394	CAP	MYLAR	.15 MFD	100 V	10%	09023	WMF1P15
C16	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C17	100012	CAP	CERAM	33 PFD	500 V	10%	71471	TCD-DI-1(N750)
C18	120130	CAP	MYLAR	.15 MFD	100 V	5%	27556	XT2B154J
C19	121394	CAP	MYLAR	.15 MFD	100 V	10%	09023	WMF1P15
C20	100081	CAP	CERAM	4.7 PFD	1000 V		56289	C030B102E4R7D
C21	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C22	110151	CAP	TANTA	10 MFD	25 V	20%	05397	K10E25
C23	110125	CAP	TANTA	2.2 MFD	35 V		71468	4321217122
C24	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C25	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C26	120025	CAP	MYLAR	1.5 MFD	100 V	10%	27556	XA2B155K
C27	100012	CAP	CERAM	33 PFD	500 V	10%	71471	TCD-DI-1(N750)
C28	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C29	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C30	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
CR1	220004	DIODE	SILICO	ZENER	1N961B		81349	1N961B
CR2	220004	DIODE	SILICO	ZENER	1N961B		81349	1N961B
CR3	210035	DIODE			5082-2810		50434	5082-2810
CR4	210035	DIODE			5082-2810		50434	5082-2810
Q1	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q2	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q3	200201	TRANS	DUAL	NPN	MPS301			MPS301
Q4	200197	TRANS	SILICO	NPN	MPS-H10		04713	MPS-H10

403667 – Assy., PCB, AC CONVERTER *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
Q5	200197	TRANS	SILICO	NPN	MPS-H10		04713	MPS-H10
Q6	200178	TRANS			2N5910		81349	2N5910
Q8	200197	TRANS	SILICO	NPN	MPS-H10		04713	MPS-H10
Q9	200197	TRANS	SILICO	NPN	MPS-H10		04713	MPS-H10
Q10	200178	TRANS			2N5910		81349	2N5910
Q11	200197	TRANS	SILICO	NPN	MPS-H10		04713	MPS-H10
Q12	200201	TRANS	DUAL	NPN	MPS301			MPS301
Q13	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q14	200200	TRANS		NPN	SKA8085		01295	SKA8085
R1	000100	RES	CARBON	10 OHM		5% 1/4W	81349	RC07GF100J
R2	010727	RES	METAL	2.5 K		.01%	18612	V53-3M
R3	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R4	010650	RES	METAL	1 M		1%	81349	RN55E
R5	040234	POT	CERMET	50 K	89PR50K		73138	89PR50K
R6	000333	RES	CARBON	33 K		5% 1/4W	81349	RC07GF333J
R7	010650	RES	METAL	1 M		1%	81349	RN55E
R8	000105	RES	CARBON	1 M		5% 1/4W	81349	RC07GF105J
R9	000163	RES	CARBON	16 K		5% 1/4W	81349	RC07GF163J
R10	000183	RES	CARBON	18 K		5% 1/4W	81349	RC07GF183J
R11	000332	RES	CARBON	3.3 K		5% 1/4W	81349	RC07GF332J
R13	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R14	000151	RES	CARBON	150 OHM		5% 1/4W	81349	RC07GF151J
R15	010529	RES	METAL	10 K	T-0	1%	81349	RN55D
R17	000512	RES	CARBON	5.1 K		5% 1/4W	81349	RC07GF512J
R18	010660	RES	METAL	5 K		.01%	18612	V53-1
R19	000333	RES	CARBON	33 K		5% 1/4W	81349	RC07GF333J
R20	000101	RES	CARBON	100 OHM		5% 1/4W	81349	RC07GF101J
R21	000510	RES	CARBON	51 OHM		5% 1/4W	81349	RC07GF510J
R22	000101	RES	CARBON	100 OHM		5% 1/4W	81349	RC07GF101J
R23	010829	RES	METAL	4.99 K		1%	81349	RN55C
R24	000161	RES	CARBON	160 OHM		5% 1/4W	81349	RC07GF161J
R25	000911	RES	CARBON	190 OHM		5% 1/4W	81349	RC07GF911J
R26	010529	RES	METAL	10 K	T-0	1%	81349	RN55D
R27	000101	RES	CARBON	100 OHM		5% 1/4W	81349	RC07GF101J
R28	000101	RES	CARBON	100 OHM		5% 1/4W	81349	RC07GF101J
R29	000153	RES	CARBON	15 K		5% 1/4W	81349	RC07GF153J
R30	000751	RES	CARBON	750 OHM		5% 1/4W	81349	RC07GF751J
R31	000821	RES	CARBON	820 OHM		5% 1/4W	81349	RC07GF821J
R32	010661	RES	METAL	10 K		.01%	18612	V53-3M
R33	010808	RES	METAL	10 K		.1%	81349	RN55C
R34	010650	RES	METAL	1 M		1%	81349	RN55E

403667 – Assy., PCB, AC CONVERTER *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
R35	040234	POT	CERMET	50 K	89PR50K		73138	89PR50K
R36	000105	RES	CARBON	1 M		5% 1/4W	81349	RC07GF105J
R37	010650	RES	METAL	1 M		1%	81349	RN55E
R38	000562	RES	CARBON	5.6 K		5% 1/4W	81349	RC07GF562J
R39	020657	RES	WW	11.109 K		.01% 1/8W	22045	J-110
R40	000113	RES	CARBON	11 K		5% 1/4W	81349	RC07GF113J
R41	000201	RES	CARBON	200 OHM		5% 1/4W	81349	RC07GF201J
R42	000107	RES	CARBON	100 M		5% 1/4W	81349	RC07GF107J
R43	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R44	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
AR1	230054	INTEGRATED CIRCUIT			LM301A		27014	LM301A
AR2	230103	INTEGRATED CIRCUIT			LM308		27014	LM308
AR3	230103	INTEGRATED CIRCUIT			LM308		27014	LM308
W1	600245	JUMPER			L-2007-1			L-2007-1

403774 – Assy., PCB, RMS AC CONVERTER

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
B1	920563	BEADS			56-59065-4B		02114	56-59065-4B
C1	130116	CAP	MICA	4000 PFD	500 V	2%	72136	DM19
C2	130115	CAP	MICA	346 PFD	500 V	2%	72136	DM15
C3	100002	CAP	CERAM	4.7 PFD	(FSV)	10%	71471	TCD (N750)
C4	130124	CAP	TRIMMER	1.2-10 PFD	250 V			R-TRIKO-122-09SD
C5	100002	CAP	CERAM	4.7 PFD	(FSV)	10%	71471	TCD (N750)
C6	100054	CAP	CERAM	27 PFD	1 KV	5%	56289	10TCCQ27
C7	130123	CAP	TRIMMER	1-3 PFD	250 V			R-TRIKO-122-09SD
C8	100050	CAP	CERAM	2.2 PFD	1 KV	5%	56289	10TCCV22
C9	130146	CAP	TRIMMER	.25-1.5 PFD	273-0001-002		74970	273-0001-002
C10	100095	CAP	CERAM	2.7±.5 PFD	500 V	(FSV)	56289	
C11	130146	CAP	TRIMMER	.25-1.5 PFD	273-0001-002		74970	273-0001-002
C12	120280	CAP	MYLAR	.22 MFD	1000 V		27556	ZA2J224K
C14	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C15	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C16	101098	CAP	CERAM	330 PFD	500 V	10%	71471	SCD1X5F
C17	101641	CAP	CERAM	470 PFD	500 V	10%	71471	SCD1X5F
C18	110126	CAP	TANTA	6.8 MFD	35 V		71468	4321217168
C19	130076	CAP	MICA	200 PFD	500 V	5%	72136	DM15-201J
C20	101642	CAP	CERAM	150 PFD	500 V	10%	71471	SCD2X5F
C21	120026	CAP	MYLAR	.47 MFD	100 V	10%	27556	SA2B474K
C22	101174	CAP	CERAM	.001 MFD	500 V	10%	71471	SCD3X5F
C23	120026	CAP	MYLAR	.47 MFD	100 V	10%	27556	SA2B474K
C24	120026	CAP	MYLAR	.47 MFD	100 V	10%	27556	SA2B474K
C25	101644	CAP	CERAM	200 PFD	1000 V	20%		
C26	101098	CAP	CERAM	330 PFD	500 V	10%	71471	SCD1X5F
C27	100051	CAP	CERAM	3.0 PFD	1 KV	(FSV)	71471	TCD-D1-0
C29	110140	CAP	TANTA	47 MFD	6.3 V		71468	4321212247
C30	120286	CAP	MYLAR	.1 MFD	100 V	20%	73445	C281AH/A100K
C31	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
CR4	211083	DIODE	SILICO		018		21793	211083
CR5	211083	DIODE	SILICO		018		21793	211083
CR6	211083	DIODE	SILICO		018		21793	211083
CR8	210035	DIODE			5082-2810		50434	5082-2810
CR9	210035	DIODE			5082-2810		50434	5082-2810
CR10	211083	DIODE	SILICO		018		21793	211083
CR11	220022	DIODE	SILICO	ZENER	1N965B		81349	1N965B
CR12	220022	DIODE	SILICO	ZENER	1N965B		81349	1N965B
CR13	220022	DIODE	SILICO	ZENER	1N965B		81349	1N965B

403774 – Assy., PCB, RMS AC CONVERTER *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
K1	310078	REED RELAY SHIELD 28 V	15636	R2690-3
K2	310078	REED RELAY SHIELD 28 V	15636	R2690-3
K3	310078	REED RELAY SHIELD 28 V	15636	R2690-3
Q1	200200	TRANS NPN SKA8085	01295	SKA8085
Q2	200200	TRANS NPN SKA8085	01295	SKA8085
Q4	200199	TRANS FET FM1302	27014	FM1302
Q5	200200	TRANS NPN SKA8085	01295	SKA8085
Q6	200201	TRANS DUAL NPN MPS301		MPS301
Q7	200112	TRANS MATCHED PAIR 2N4250	80131	2N4250
Q8	200112	TRANS MATCHED PAIR 2N4250	80131	2N4250
Q9	200068	TRANS 2N4250	80131	2N4250
Q10	200200	TRANS NPN SKA8085	01295	SKA8085
Q11	200220	TRANS DUAL		
Q12	200136	TRANS 2N5963	81349	2N5963
Q13	200068	TRANS 2N4250	80131	2N4250
Q14	403819	TRANS DUAL LOG TRANS KIT	21793	403819
Q15	403819	TRANS DUAL LOG TRANS KIT	21793	403819
Q19	200068	TRANS 2N4250	80131	2N4250
Q20	200197	TRANS SILICO NPN MPS-H10	04713	MPS-H10
Q21	200197	TRANS SILICO NPN MPS-H10	04713	MPS-H10
AR1	230180	INTEGRATED CIRCUIT LM318H	27014	LM318H
AR2	230054	INTEGRATED CIRCUIT LM301A	27014	LM301A
R1	010721	RES METAL MATCHED SET	81349	RN75
R2	010720	RES METAL 9.09 K T-2 .25%	81349	RN55C
R3	040228	POT CERMET 500 OHM 10%	73138	89P Series
R4	010721	RES METAL MATCHED SET	81349	RN75
R5	040225	POT CERMET 50 OHM 20%	73138	89P Series
R6	010721	RES METAL MATCHED SET	81349	RN75
R7	040228	POT CERMET 500 OHM 10%	73138	89P Series
R8	010721	RES METAL MATCHED SET	81349	RN75
R9	000242	RES CARBON 2.4 K 5% 1/4W	81349	RC07GF242J
R10	010721	RES METAL MATCHED SET	81349	RN75
R11	000182	RES CARBON 1.8 K (FSV) 5% 1/4W	81349	RC07GF182J
R12	010542	RES METAL 100 K 1%	81349	RN55E
R13	010542	RES METAL 100 K 1%	81349	RN55E
R14	001737	RES CARBON (FSV) 5% 1/4W	21793	001737
R15	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R16	000514	RES CARBON 510 K 5% 1/4W	81349	RC07GF514J
R17	040235	POT CERMET 100 K 10%	73138	89P Series

403774 – Assy., PCB, RMS AC CONVERTER *continued*

REF DES	DANA P/N	DESCRIPTION						FSC	MANU P/N
R18	000183	RES	CARBON	18 K		5%	1/4W	81349	RC07GF183J
R23	000101	RES	CARBON	100 OHM		5%	1/4W	81349	RC07GF101J
R24	010586	RES	METAL	5 K		.02%		18612	V53-1M
R25	010586	RES	METAL	5 K		.02%		18612	V53-1M
R26	010654	RES	METAL	20 K		.05%		18612	V53-1
R27	010615	RES	METAL	10 K		.02%		18612	V53-1M
R28	040225	POT	CERMET	50 OHM		20%		73138	89P Series
R29	000512	RES	CARBON	5.1 K		5%	1/4W	81349	RC07GF512J
R30	000105	RES	CARBON	1 M		5%	1/4W	81349	RC07GF105J
R31	040235	POT	CERMET	100 K		10%		73138	89P Series
R32	000184	RES	CARBON	180 K		5%	1/4W	81349	RC07GF184J
R33	040225	POT	CERMET	50 OHM		20%		73138	89P Series
R34	010684	RES	METAL	487 OHM	T-9	1%		81349	RN55E4870F
R35	010684	RES	METAL	487 OHM	T-9	1%		81349	RN55E4870F
R36	000101	RES	CARBON	100 OHM		5%	1/4W	81349	RC07GF101J
R37	000123	RES	CARBON	12 K		5%	1/4W	81349	RC07GF123J
R38	000272	RES	CARBON	2.7 K		5%	1/4W	81349	RC07GF272J
R39	000101	RES	CARBON	100 OHM		5%	1/4W	81349	RC07GF101J
R40	000681	RES	CARBON	680 OHM		5%	1/4W	81349	RC07GF681J
R41	040239	POT	CERMET	1 M		20%		73138	89P Series
R42	040232	POT		10 K	89P Series			73138	89P Series
R43	010621	RES	METAL	49.9 K	T-0	1%		81349	RN55C4992F
R44	000476	RES	CARBON	47 M		5%	1/4W	81349	RC07GF476J
R45	000103	RES	CARBON	10 K		5%	1/4W	81349	RC07GF103J
R46	010070	RES	METAL	27.4 K	T-0	1%		81349	RN60D2742F
R47	000392	RES	CARBON	3.9 K		5%	1/4W	81349	RC07GF392J
R49	000107	RES	CARBON	100 M		5%	1/4W	81349	RC07GF107J
R50	000104	RES	CARBON	100 K		5%	1/4W	81349	RC07GF104J
R51	020667	RES	WW	100 K		.1%		22045	J-110
R52	001737	RES	CARBON	(FSV)		5%	1/4W	21793	001737
R53	001768	RES	CARBON	3.3 OHM		5%	1/4W		
R54	040225	POT	CERMET	50 OHM		20%		73138	89P Series
R55	010654	RES	METAL	20 K		.05%		18612	V53-1
R56	001737	RES	CARBON	(FSV)		5%	1/4W	21793	001737
R57	010654	RES	METAL	20 K		.05%		18612	V53-1
R58	040227	POT	CERMET	200 OHM		10%		73138	89P Series
R59	001737	RES	CARBON	(FSV)		5%	1/4W	21793	001737
R60	010615	RES	METAL	10 K		.02%		18612	V53-1M
R61	000101	RES	CARBON	100 OHM		5%	1/4W	81349	RC07GF101J
R62	000104	RES	CARBON	100 K		5%	1/4W	81349	RC07GF104J
R63	000470	RES	CARBON	47 OHM		5%	1/4W	81349	RC07GF470J
R64	000820	RES	CARBON	82 OHM		5%	1/4W	81349	RC07GF820J

403774 – Assy., PCB, RMS AC CONVERTER *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
R70	000513	RES	CARBON	51 K		5% 1/4W	81349	RC07GF513J
R71	000512	RES	CARBON	5.1 K	(FSV)	5% 1/4W	81349	RC07GF512J
R72	010618	RES	METAL	200 K		.25%	81349	RN55C
R73	010536	RES	METAL	100 K	T-0	1%	81349	RN55D1003F
R74	403819	TRANS	DUAL	LOG TRANS KIT			21793	403819
R75	403819	TRANS	DUAL	LOG TRANS KIT			21793	403819
R76	010496	RES	METAL	1 M	T-0	1%	81349	RN60D
R77	000221	RES	CARBON	220 OHM		5% 1/4W	81349	RC07GF221J
R78	000221	RES	CARBON	220 OHM		5% 1/4W	81349	RC07GF221J
R79	000512	RES	CARBON	5.1 K	(FSV)	5% 1/4W	81349	RC07GF512J
R80	000474	RES	CARBON	470 K	(FSV)	5% 1/4W	81349	RC07GF474J
S1	600742	SWITCH	SLIDE		G-111		79727	G-111
S2	600742	SWITCH	SLIDE		G-111		79727	G-111
TP1	600591	POST	TEST POINT		85931-6		89110	85931-6
TP2	600591	POST	TEST POINT		85931-6		89110	85931-6
TP3	600591	POST	TEST POINT		85931-6		89110	85931-6
TP4	600591	POST	TEST POINT		85931-6		89110	85931-6
TP5	600591	POST	TEST POINT		85931-6		89110	85931-6

403674 – Assy., PCB, SCALING AMPLIFIER (Figure 6.21)

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
B1	920563	BEAD	SHIELDING		56-59065-4B		02114	56-59065-4B
B2	920563	BEAD	SHIELDING		56-59065-4B		02114	56-59065-4B
C1	130127	CAP		40 PFD	10S-TRIKO-24N750			10S-TRIKO-24N750
C2	130116	CAP	MICA	4000 PFD	500 V	2%	72136	DM19
C3	120275	CAP	POLY	1000 PFD	500 V	2.5%	08257	KSC Series
C4	130115	CAP	MICA	346 PFD	500 V	2%	72136	DM15
C5	120274	CAP	POLY	87 PFD	500 V	2.5%	08257	KSO Series
C6	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C7	100075	CAP	CERAM	10 PFD	1000 V		56289	10TCCQ10
C8	130124	CAP	CERAM	10 PFD	250 V			R-TRIKO-122-09SD
C9	100100	CAP	CERAM	FSV	100100		21793	100100
C10	130123	CAP	CERAM	3 PFD	250 V			R-TRIKO-122-09SD
C11	100050	CAP		2.2 PFD	1000 V	5%	56289	10TCCV22
C12	100061	CAP	CERAM	39 PFD	1000 V	5%	56289	10TCCQ39
C13	100084	CAP	CERAM	1.5 PFD	1000 V		56289	10TCCV15
C14	120090	CAP	MYLAR	.22 MFD	600 V	5%	27556	ZA1101J
C15	100077	CAP	GLASS	7.5 PFD	500 V	5%	95275	VY10CA7R5JA
C16	100075	CAP	CERAM	10 PFD	1000 V		56289	10TCCQ10
C17	100075	CAP	CERAM	10 PFD	1000 V		56289	10TCCQ10
C18	100077	CAP	GLASS	7.5 PFD	500 V	5%	95275	VY10CA7R5JA
C19	130125	CAP		10 PFD	250 V		91293	JMC2951
C20	130125	CAP		10 PFD	250 V		91293	JMC2951
C21	110141	CAP	TANTA	22 MFD	16 V	20%	05397	K22E16
C22	110140	CAP	TANTA	47 MFD	6.3 V		71468	4321212247
C23	110140	CAP	TANTA	47 MFD	6.3 V		71468	4321212247
C24	110140	CAP	TANTA	47 MFD	6.3 V		71468	4321212247
C25	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C26	101174	CAP	CERAM	.001 MFD	500 V	10%	71471	SCD3X5F
C28	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C29	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C31	110140	CAP	TANTA	47 MFD	6.3 V		71468	4321212247
C32	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C33	100079	CAP	CERAM	3.9 PFD	1000 V		56289	10TCCV39
C34	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C35	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C36	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C37	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168
C38	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C39	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C40	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C41	110126	CAP	TANTA	6.8 MFD	35 V		71468	431217168

403674 – Assy., PCB, SCALING AMPLIFIER *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
C42	100074	CAP	CERAM	5 PFD	1000 V		56289	10TCCV50
C43	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C44	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C45	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
CR1	211083	DIODE	SILICO		018		21793	211083
CR2	211083	DIODE	SILICO		018		21793	211083
CR3	211083	DIODE	SILICO		018		21793	211083
CR4	210035	DIODE			5082-2810		50434	5082-2810
CR5	210035	DIODE			5082-2810		50434	5082-2810
CR6	210035	DIODE			5082-2810		50434	5082-2810
CR7	210035	DIODE			5082-2810		50434	5082-2810
CR9	211083	DIODE	SILICO		018		21793	211083
CR10	211083	DIODE	SILICO		018		21793	211083
CR11	220004	DIODE	SILICO	ZENER	1N961B		81349	1N961B
CR12	220022	DIODE	SILICO	ZENER	1N965B		81349	1N965B
CR13	220022	DIODE	SILICO	ZENER	1N965B		81349	1N965B
CR14	211083	DIODE	SILICO		018		21793	211083
K1	310078	RELAY	REED SHIELD		R2690-3		15636	R2690-3
K2	310077	RELAY	REED SHIELD		R2691-3		15636	R2691-3
K3	310078	RELAY	REED SHIELD		R2690-3		15636	R2690-3
L1	310068	CHOKE		1 μh	1537-12		99800	1537-12
Q1	200197	TRANS	SILICO	NPN	MPS-H10		04713	MPS-H10
Q2	200161	TRANS	DUAL	FET	E415		17856	E415
Q3	200197	TRANS	SILICO	NPN	MPS-H10		04713	MPS-H10
Q4	200197	TRANS	SILICO	NPN	MPS-H10		04713	MPS-H10
Q5	200197	TRANS	SILICO	NPN	MPS-H10		04713	MPS-H10
Q6	200197	TRANS	SILICO	NPN	MPS-H10		04713	MPS-H10
Q7	200178	TRANS			2N5910		81349	2N5910
Q8	200197	TRANS	SILICO	NPN	MPS-H10		04713	MPS-H10
Q9	200178	TRANS			2N5910		81349	2N5910
Q10	200197	TRANS	SILICO	NPN	MPS-H10		04713	MPS-H10
Q11	200197	TRANS	SILICO	NPN	MPS-H10		04713	MPS-H10
R1	010721	RES	METAL	1.1324 K	Matched Set	.1%	81349	RN75
R2	010720	RES	METAL	9.09 K	T-2	.25%	81349	RN55C
R3	040228	POT	CERMET	500 OHM		10%	73138	89P
R4	000152	RES	CARBON	1.5 K		5% 1/4W	81349	RC07GF152J
R5	010721	RES	METAL	11.000 K	Matched Set	.1%	81349	RN75

403674 – Assy., PCB, SCALING AMPLIFIER *continued*

REF DES	DANA P/N	DESCRIPTION						FSC	MANU P/N
R6	010798	RES	METAL	82.5 OHM		1%		81349	RN55C
R7	040225	POT	CERMET	50 OHM		20%		73138	89P Series
R8	040228	POT	CERMET	500 OHM		10%		73138	89PR500
R9	010721	RES	METAL	110.86 K	Matched Set	.1%		81349	RN75
R10	010721	RES	METAL	1 M	Matched Set	.1%		81349	RN75
R11	041179	POT		5 K	50-1-1-502			02111	50-1-1-502
R12	010721	RES	METAL	997.5 K	Matched Set	.1%		81349	RN75
R13	000163	RES	CARBON	16 K		5%	1/4W	81349	RC07GF163J
R14	010536	RES	METAL	100 K	T-0	1%		81349	RN55D1003F
R15	000510	RES	CARBON	51 OHM		5%	1/4W	81349	RC07GF510J
R16	000241	RES	CARBON	240 OHM		5%	1/4W	81349	RC07GF241J
R17	000202	RES	CARBON	2 K		5%	1/4W	81349	RC07GF202J
R18	010583	RES	METAL	182 OHM		1%		81349	RN55D
R19	040258	POT	CERMET	100 OHM		20%	.5 W	73138	72XW100
R20	010827	RES	METAL	8.25 K		1%		81349	RN55C
R21	010813	RES	METAL	7.87 K		1%		81349	RN55C7871F
R22	010583	RES	METAL	182 OHM		1%		81349	RN55D
R23	000510	RES	CARBON	51 OHM		5%	1/4W	81349	RC07GF510J
R24	010536	RES	METAL	100 K	T-0	1%		81349	RN55D1003F
R25	000101	RES	CARBON	100 OHM		5%	1/4W	81349	RC07GF101J
R26	000183	RES	CARBON	18 K		5%	1/4W	81349	RC07GF183J
R27	000183	RES	CARBON	18 K		5%	1/4W	81349	RC07GF183J
R28	000102	RES	CARBON	1 K		5%	1/4W	81349	RC07GF102J
R29	000223	RES	CARBON	22 K		5%	1/4W	81349	RC07GF223J
R30	000621	RES	CARBON	620 OHM		5%	1/4W	81349	RC07GF621J
R31	000682	RES	CARBON	6.8 K		5%	1/4W	81349	RC07GF682J
R32	000680	RES	CARBON	68 OHM		5%	1/4W	81349	RC07GF680J
R33	000680	RES	CARBON	68 OHM		5%	1/4W	81349	RC07GF680J
R34	000160	RES	CARBON	16 OHM		5%	1/4W	81349	RC07GF160J
R35	000241	RES	CARBON	240 OHM		5%	1/4W	81349	RC07GF241J
R36	000474	RES	CARBON	470 K		5%	1/4W	81349	RC07GF474J
R37	000203	RES	CARBON	20 K		5%	1/4W	81349	RC07GF203J
R38	000203	RES	CARBON	20 K		5%	1/4W	81349	RC07GF203J
R39	000301	RES	CARBON	300 OHM		5%	1/4W	81349	RC07GF301J
R40	000103	RES	CARBON	10 K		5%	1/4W	81349	RC07GF103J

403627 – Assy., PCB, OHMS CONVERTER (Figure 6.23)

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
C1	120034	CAP	POLY	100 PFD	500 V	5%	08257	KSO Series
C2	120004	CAP	POLY	.001 MFD	500 V	5%	08257	KSO Series
C3	120004	CAP	POLY	.001 MFD	500 V	5%	08257	KSO Series
C4	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C5	100012	CAP	CERAM	33 PFD		10%	71471	TCD-DI-1(N750)
C6	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C7	120227	CAP	POLY	220 PFD	630 V	5%	08257	KSO Series
C8	120227	CAP	POLY	220 PFD	630 V	5%	08257	KSO Series
C9	100012	CAP	CERAM	33 PFD		10%	71471	TCD-DI-1(N750)
C10	100071	CAP	CERAM	.001 MFD	1000 V	20%	56289	5GA-D10
C11	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
CR1	220005	DIODE	SILICO	ZENER	1.5M20Z10		04713	1.5M20Z10
CR2	220015	DIODE	SILICO	ZENER	1N967B		81349	1N967B
CR3	211083	DIODE	SILICO		018		21793	211083
CR4	211083	DIODE	SILICO		018		21793	211083
CR5	211083	DIODE	SILICO		018		21793	211083
CR6	211083	DIODE	SILICO		018		21793	211083
CR7	211083	DIODE	SILICO		018		21793	211083
CR8	211083	DIODE	SILICO		018		21793	211083
CR9	210048	DIODE			600 V		81349	1N4005
CR10	211083	DIODE	SILICO		018		21793	211083
CR11	211083	DIODE	SILICO		018		21793	211083
CR12	211083	DIODE	SILICO		018		21793	211083
CR13	211083	DIODE	SILICO		018		21793	211083
CR14	211083	DIODE	SILICO		018		21793	211083
CR15	211083	DIODE	SILICO		018		21793	211083
CR16	211083	DIODE	SILICO		018		21793	211083
CR17	211083	DIODE	SILICO		018		21793	211083
CR18	211083	DIODE	SILICO		018		21793	211083
CR19	211083	DIODE	SILICO		018		21793	211083
CR20	211083	DIODE	SILICO		018		21793	211083
CR21	211083	DIODE	SILICO		018		21793	211083
K1	310077	RELAY	REED SHIELD		R2691-3		15636	R2691-3
K2	310077	RELAY	REED SHIELD		R2691-3		15636	R2691-3
K3	310113	RELAY	REED SHIELD		R4092-3		15636	R4092-3
K4	310077	RELAY	REED SHIELD		R2691-3		15636	R2691-3
K5	310077	RELAY	REED SHIELD		R2691-3		15636	R2691-3
K6	310077	RELAY	REED SHIELD		R2691-3		15636	R2691-3

403627 – Assy., PCB, OHMS CONVERTER *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
Q1	200101	TRANS	FET		2N5245		81349	2N5245
Q2	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q3	200191	TRANS		PNP	2N1305		81349	2N1305
Q4	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q5	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q6	200201	TRANS	DUAL	NPN	MPS301			MPS301
Q7	200201	TRANS	DUAL	NPN	MPS301			MPS301
Q8	200201	TRANS	DUAL	NPN	MPS301			MPS301
Q9	200088	TRANS	SILICO	PNP	2N4248		80131	2N4248
Q10	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q11	200088	TRANS	SILICO	PNP	2N4248		80131	2N4248
Q12	200068	TRANS			2N4250		80131	2N4250
Q13	200198	TRANS		PNP	MPS-A92		04713	MPS-A92
Q14	200198	TRANS		PNP	MPS-A92		04713	MPS-A92
Q15	200068	TRANS			2N4250		80131	2N4250
Q16	200198	TRANS		PNP	MPS-A92		04713	MPS-A92
Q17	200198	TRANS		PNP	MPS-A92		04713	MPS-A92
Q18	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q19	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q20	200088	TRANS	SILICO	PNP	2N4248		80131	2N4248
Q21	200088	TRANS	SILICO	PNP	2N4248		80131	2N4248
Q22	200088	TRANS	SILICO	PNP	2N4248		80131	2N4248
Q23	200088	TRANS	SILICO	PNP	2N4248		80131	2N4248
Q24	200200	TRANS		NPN	SKA8085		01295	SKA8085
Q25	200200	TRANS		NPN	SKA8085		01295	SKA8085
R1	000104	RES	CARBON	100 K		5% 1/4W	81349	RC07GF104J
R2	000103	RES	CARBON	10 K		5% 1/4W	81349	RC07GF103J
R3	000246	RES	CARBON	24 M		5% 1/4W	81349	RC07GF246J
R4	030005	RES	CARBON	100 K		5% 2 W	81349	RC42GF104J
R5	040235	POT	CERMET	100 K	89PR100K		73138	89PR100K
R6	010598	RES		20 K		1%	81349	RN60C2002F
R7	010137	RES		100 OHM		1%	81349	RN60D1000F
R8	010780	RES	WW	499 K		1%	81349	RN60E
R9	040235	POT	CERMET	100 K	89PR100K		73138	89PR100K
R10	000107	RES	CARBON	100 M		5% 1/4W	81349	RC07GF107J
R11	000755	RES	CARBON	7.5 M		5% 1/4W	81349	RC07GF755J
R12	010785	RES		5333.1 OHM		.01%	18612	V53-1
R13	010786	RES		8000 OHM		.01%	18612	V53-1
R14	010598	RES		20 K		1%	81349	RN60C2002F
R15	010337	RES	METAL	10 M		1%	91637	DCS1-2
R16	010777	RES	METAL	39.99 K	T-9	.1%	03888	PME55

403627 – Assy., PCB, OHMS CONVERTER *continued*

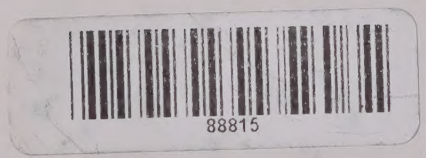
REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
R17	010337	RES	METAL	10 M		1%	91637	DCS1-2
R18	000136	RES	CARBON	13 M		5% 1/4W	81349	RC07GF136J
R19	010780	RES	WW	499 K		1%	81349	RN60E
R20	010120	RES	METAL	68.1 K		1% 1/4W	81349	RN60D6812F
R21	010431	RES		511 K		1%	81349	RN60C5113F
R22	040235	POT	CERMET	100 K	89PR100K		73138	89PR100K
R23	010598	RES	METAL	20 K		1%	81349	RN60C2002F
R24	010780	RES	WW	499 K		1%	81349	RN60E
R25	010780	RES	WW	499 K		1%	81349	RN60E
R26	010784	RES	METAL	4.7 M		1%	91637	DC-1/4
R27	010780	RES	WW	499 K		1%	81349	RN60E
R28	000393	RES	CARBON	39 K		5% 1/4W	81349	RC07GF393J
R29	000112	RES	CARBON	1.1 K		5% 1/4W	81349	RC07GF112J
R30	000816	RES		47 K		5% 2 W	81349	RC07GF816J
R31	000816	RES		47 K		5% 2 W	81349	RC07GF816J
R32	000202	RES	CARBON	2 K		5% 1/4W	81349	RC07GF202J
R33	000205	RES	CARBON	2 M		5% 1/4W	81349	RC07GF205J
R34	000205	RES	CARBON	2 M		5% 1/4W	81349	RC07GF205J
R35	010789	RES	METAL	4000.4 OHM		.01%	18612	S104
R36	040235	POT	CERMET	100 K	89PR100K		73138	89PR100K
R37	010536	RES	METAL	100 K	T-0	1%	81349	RN55D1003F
R38	000205	RES	CARBON	2 M		5% 1/4W	81349	RC07GF205J
R39	000205	RES	CARBON	2 M		5% 1/4W	81349	RC07GF205J
R40	010788	RES	METAL	445.71 OHM		.05%	18612	S104
R41	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R42	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R43	040226	POT	CERMET	100 OHM		10%	73138	89P Series
R44	020669	RES	WW	100.050 K		.02%	22045	J-160
R45	040230	POT	CERMET	2 K	89PR2K		73138	89PR2K
R46	020612	RES	WW	1.009 M		.05% 1/4W	22045	J-120
R47	040234	POT	CERMET	50 K	89PR50K		73138	89PR50K
R48	010655	RES	METAL	11.086 M	T-9	.1%	03888	PME70
R49	010654	RES	METAL	20 K		.05%	18612	V53-1
R50	010586	RES	METAL	5 K		.02%	18612	V53-1M
R51	040235	POT	CERMET	100 K		10%	73138	89PR100K
R52	010656	RES	METAL	19.948 M	T-9	.1%	03888	PME75
R53	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R54	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R55	000203	RES	CARBON	20 K		5% 1/4W	81349	RC07GF203J
R56	040234	POT	CERMET	50 K	89PR50K		73138	89PR50K
R57	001759	RES	CARBON	5.1 OHM		5% 1/4W		
R58	000470	RES	CARBON	47 OHM		5% 1/4W	81349	RC07GF470J

403627 – Assy., PCB, OHMS CONVERTER *continued*

REF DES	DANA P/N	DESCRIPTION		FSC	MANU P/N
AR1	230054	INTEGRATED CIRCUIT	LM301A	27014	LM301A
AR2	230054	INTEGRATED CIRCUIT	LM301A	27014	LM301A

403673 – Assy., PCB, 4-WIRE RATIO (Figure 6.25)

REF DES	DANA P/N	DESCRIPTION						FSC	MANU P/N
C1	100012	CAP	CERAM	33 PFD		10%		71471	TCD-DI-1(N750)
C2	100017	CAP	CERAM	.01 MFD	100 V	20%		56289	TG-S10
C3	100012	CAP	CERAM	33 PFD		10%		71471	TCD-DI-1(N750)
C4	110158	CAP	TANTA	10 MFD	50 V			05397	K10E50
C5	100017	CAP	CERAM	.01 MFD	100 V	20%		56289	TG-S10
C6	120308	CAP		.047 MFD		10%		73445	C280MAE/A47K
C7	120312	CAP	POLY	.022 MFD	250 V	10%		73445	C280MAE/A22K
Q1	200200	TRANS		NPN	SKA8085			01295	SKA8085
Q2	200200	TRANS		NPN	SKA8085			01295	SKA8085
R1	010033	RES	METAL	49.9 K		1%		81349	RN60D4992F
R2	010033	RES	METAL	49.9 K		1%		81349	RN60D4992F
R3	010621	RES	METAL	49.9 K	T-0	1%		81349	RN55C4992F
R4	010621	RES	METAL	49.9 K	T-0	1%		81349	RN55C4992F
R5	010787	RES	METAL	20 K		.02%		18612	V53-1
R6	010787	RES	METAL	20 K		.02%		18612	V53-1
R7	000100	RES	CARBON	10 OHM		5%	1/4W	81349	RC07GF100J
R8	010787	RES	METAL	20 K		.02%		18612	V53-1
R9	040229	POT	CERMET	1 K		10%		73138	89PR1K
R10	040229	POT	CERMET	1 K		10%		73138	89PR1K
R11	000100	RES	CARBON	10 OHM		5%	1/4W	81349	RC07GF100J
R12	040235	POT	CERMET	100 K	89PR100K			73138	89PR100K
R13	000100	RES	CARBON	10 OHM		5%	1/4W	81349	RC07GF100J
R14	000390	RES	CARBON	39 OHM		5%	1/4W	81349	RC07GF390J
R15	010787	RES	METAL	20 K		.02%		18612	V53-1
AR1	230145	INTEGRATED CIRCUIT			MATCHED SET			21793	230145
AR2	230127	INTEGRATED CIRCUIT			SSS725CJ				SSS725CJ
AR3	230145	INTEGRATED CIRCUIT			MATCHED SET			21793	230145



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